

# PREDICTING THE SUCCESS RATES OF SCHOOLS USING ARTIFICIAL NEURAL NETWORK

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## ABSTRACT

The Prediction is one of the most important and prevalent topics recently. It is an estimation of what will occur in the future depending on the data obtained previously. In this paper, a model was proposed to predict the success rates of schools neural networks approach. The proposed model was trained and tested by taking the data from General Directorate of Education in Anbar for the academic year 2016-2017 then divided into two equal groups (male and female). Physics and Chemistry subjects are considered the main influent on the success rate after applying the Garson technique. It was obtained a real equation that can be used to predict future success rates for all other educational institutions with regression for Training, Validation and Testing reached to 95.161%.

**keywords:** *Artificial neural network, Prediction, Success Rate, Regression*

## 1. INTRODUCTION

The concept of prediction is a guess what will happen in the future depending on factors are previously taken and it is one of the most important and effective topics. Its importance increased in the last years after the emergence of modern and sophisticated methods especially after development of computer science and information technology are including neural networks models. These models are learning and adapting to any model because they possess high capabilities in processing large data in high speeds as a result of their ability to answer accurately.

The School is considered one of the first institutions that originated in ancient Iraq, and it was the emergence coincided with the tremendous cultural renaissance that occurred in this country after the civil settlement revolution which took place in the land of Sumer in the middle of the fourth millennium BC, and it was a direct result of the finest human invention known as the cuneiform writing, which was invented by the creative thinking of the sons of Mesopotamia in the city of Al-Warka (Sumerian) fourth layer within the limits of 3200 BC., Which it was aimed primarily at the simple pictures beginnings to record the imports of economic temples. After it which spread the

intellectual revolution and culture throughout the ancient world, marking the beginning of a new era in the history of humanity known as historical times.

The education is one of the most important branches of human building, and the main axis in the development of societies where education in pre-1991 Iraq had a learning curve of the best education at the time where the proportion of primary schools increased by approximately 30% and increased the percentage of female participation in education from 35% to 44% of the total number of students as well as increased the proportion of primary school teachers increased by almost 40%. but education suffered a lot because of the wars it suffered as in the US invasion in 2003 so many Iraqi children have gone to work because of low incomes of those families after Gulf sWar. [1][2]

Scope of this study reach to 100 degree; any result below 50 marks is considered failure in exam. In last years, scientific levels of students declined to low degrees because of refuge, bad use of mobile and games and societies media websites.

In the literature no recent studies about examination or studying of Iraqi intermediate schools. From another hand, the low scientific levels of students lead to investigate the

correlations and success percentages among subjects between male and female using mathematical routes and computing.

The students of the intermediate stage are characterized by hormonal and phylogenetic changes during adolescence, which psychologists defined as the stage that begins at the age of 12 years and ends at 18 years. Also, the spatial changes that occur to the students as they moved from their first primary school and they have changes in the buildings of classrooms and seating space as well as the difference in teaching methods is also due to the changing of their subjects from easier to more complex.

The problem of low Academic achievements is one of the most difficult problems facing the educational system in the Arab countries, as stated in the statistical report of UNICEF. He pointed out that the supplementary students in 1995 in 10 Arab countries amounted to 1036110. This results in a waste of human resources and material resources. The mentioned report of UNICEF that the students after returning them to the classroom do not achieve a good academic level [3], the problem of low academic achievement is a global problem exist in most societies, the author (Verizon) is the one of the first who cared with the problem of low achievement that he said the Twenty students out of every hundred have a low in an achievement. The report of the Organization for Economic Cooperation and Development included the percentage of students suffering from low levels achievement in mathematics and Arabic in 34 countries at the age of 15 years. The average for these countries in mathematics is 22.5% and in Arabic is (18.8%) and the low level in these subjects is negatively reflected on the other materials to adopt the last one on the first [4]. As for the decline the study in Iraq, the problem is not less than the other countries where the success rate for the scientific and literary branches for the academic year 2006 - 2007 reached (37%) was not higher than for the previous years. The problem of low level of educational achievement may be more prominent in the secondary stage because of the difference of its curricula from the primary curriculum and the different methods of teaching than those In the primary schools.

Neural Network is one of artificial intelligence types; this modern science is one of the applications of futuristic science, which is based on all modern and complex applications of

prediction and recognition systems, decision support systems, and automated control systems [5] [6][7]. The most important types of artificial intelligence are expert systems, neural networks, fuzzy logic and genetic algorithms [8]. So, neural networks were used in this work which is considered the most powerful artificial intelligence technique [9]. In other meaning, it is a simulation of the neural network of neurons in the human brain. The hypotheses and algorithms of artificial neural network are an attempt to understand the behavior of the biological neuron. Two types of networks can be distinguished are single-layer and multilayered neural network [10] [11][12]. The single-layer network contains a single layer of processing and an input layer receives and passes the inputs. The second network contains more than one layer of processing and some layers are hidden. The function of those layers increases the strength of the neural network and improves its performance. The hidden layer may be consisting of one or more neurons. Also, the layer increases the ability of the network to process data which have the ability to find the best solution and to solve any complex problem and finally it improves the performance[13] [14].

Artificial Neural Networks (ANNs) are learning in a similar way to human learning through the examples and the training [15]. They are prepared and regulated for wide applications such as the model of recognition or perception or classification of data. The learning in biological systems uses the adaptation of synapses among neurons which is considered the fundamental idea in work of neural[16] [17].

The prediction was applied in the education field in the Iraq schools because it is an important branch for the human building and the main axis in the development of societies. Pre-1991, the education in Iraq was considered one of the best education in the world due to the increases in a number of primary schools approximately up to 30%. Also, The percentage of female participation in the education increased from 35% to 44% as well as increasing number of education staffs (almost 40%) [1] [2]. After 1991, the education declined frequently because of the wars which happened in Iraq so many Iraqi children have gone to the work and left the education in schools because of low incomes of their families.

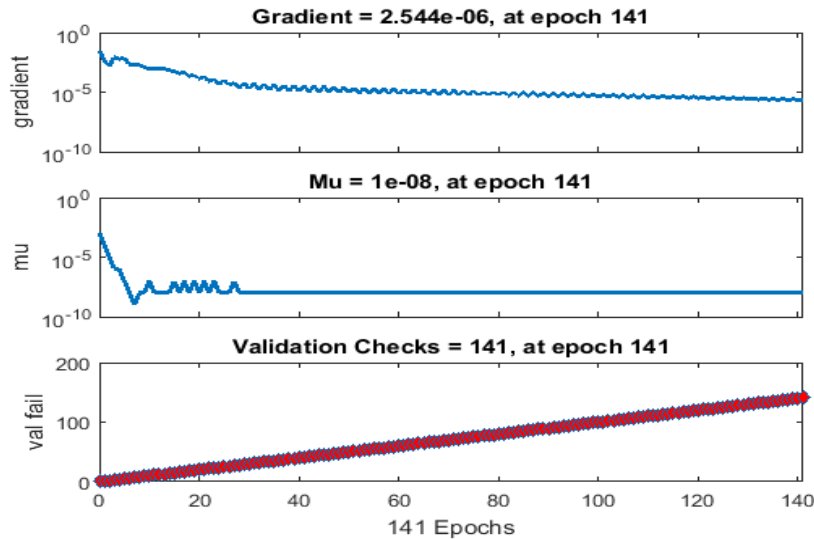


Figure 1 : Training Neural Network

Currently, it takes huge time and efforts to extract the rates and percentages of success rates for enormous number of intermediate schools. In this paper, the schools in Anbar province in Iraq has been considered as sample of our research, which consists of three stages (First, Second and Third) to predict the success rates and determine the influence of subjects that declined or boosted the success rates. Therefore, using this artificial neural networks besides Garson technique can automatically give new scores in shorthand time This work is unique study for the first time in Iraq can be linked with artificial neural network.

## 2. RELATED WORKS

There have been many studies focused on the use of neural networks in predicting the state of the future as the following:

[22] This paper presents the student's performance based on his / her habits. Data were collected from different schools that contain students' habits and comments. The data were analyzed by using the implicit analysis of the content to extract the semantics and vector support mechanism used to classify the data into two interested and uninterested sections and then use the neural networks to predict the regression of the students. [23] This paper provides a

methodology for predicting financial performance over the Internet when companies

receive data over the Internet at different time intervals using several techniques: data envelopment analysis, fuzzy C-means and artificial neural network. The neural network was trained using Tehran Stock Exchange data for years (2007–2012) to predict the future performance of the companies.

[24] This paper presents the use of neural networks to predict foreign exchange rates, where neural networks have proven their effectiveness in predicting the financial time series especially in which patterns of activity pass through the network before the results are produced as in our proposal. Three repetitive architectures were compared in terms of the accuracy of the future forecast of the German currency and very high results were obtained in predicting actual trading in the markets.

## 3. MATERIALS AND METHODS

### 3.1 Data Collection

Final degrees of hundred intermediate schools were taken from General Directorate of Education in Anbar for the academic year 2016-2017 then divided into two equal groups (male and female). The study system in this stage consists of eight subjects which are: Islamic sciences, Arabic language, English language, Social sciences, Mathematics, Biology, Chemistry, and Physics.

### 3.2. Artificial Neural Network Model

In the neural network, the data is divided into three sets. The first part is the training set that used 70% of dataset to compute the gradient and update the weights and biases of networks, i.e. train the weights until it reaches to the minimum Mean Square Error (MSE) between the outputs and targets[18]. Figure 1 show the train networks of our proposed after 141 iterations.

The second part is the validation set that used 15% for validation the generalizing network and stopping the training phase before occurrence the overfitting, the final part is the test set error that used 15% for completing an independent test of the generalizing network. Figure 2 show the tool of neural networks that proposed.

In this paper, the network consists of 8 input nodes in the input layer, 2 hidden nodes in the hidden and one output node in the output layer. The transfer functions are used TANH -TANH at hidden layer. Figure 3 illustrated the structure of the proposed neural networks.

The best performance can be used to train neural networks is mean squared error (MSE) [19] To achieve this work, the results of normalization were used in artificial neural networks to predict the success rates and applied Garson technique to know most effect on the success rates.

#### 4. RESULTS AND DISCUSSION

##### 4.1 Normalization

The essence of neural networks is ensuring the distribution values for each unique input and output. Occasionally, the input and output values have very different ranges, thus they should be normalized between 0, -1 and 1[20]. This issue is used normalization of data depended on the output transfer function, as equation 1. Figure 4 show the Normalization values of the our subject.

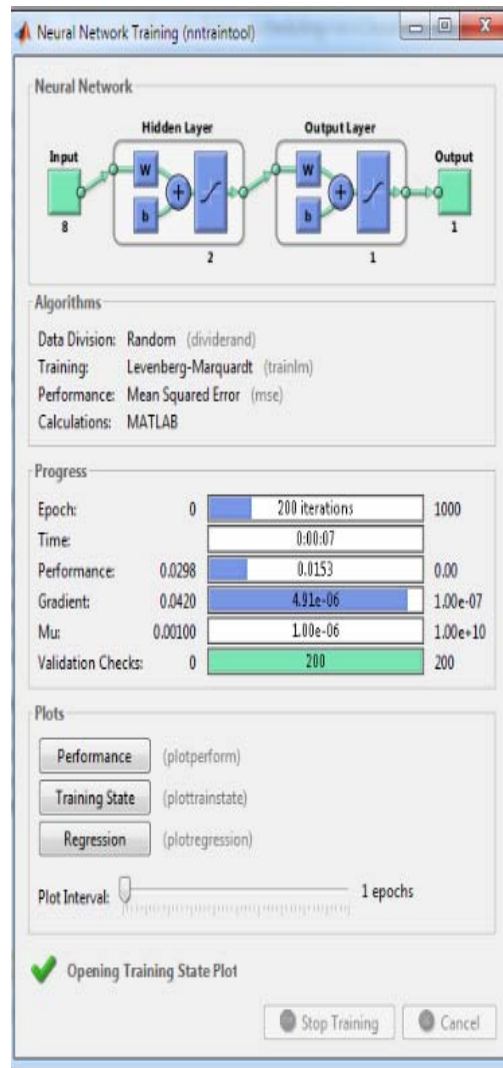


Figure 2: Structure of Neural Network

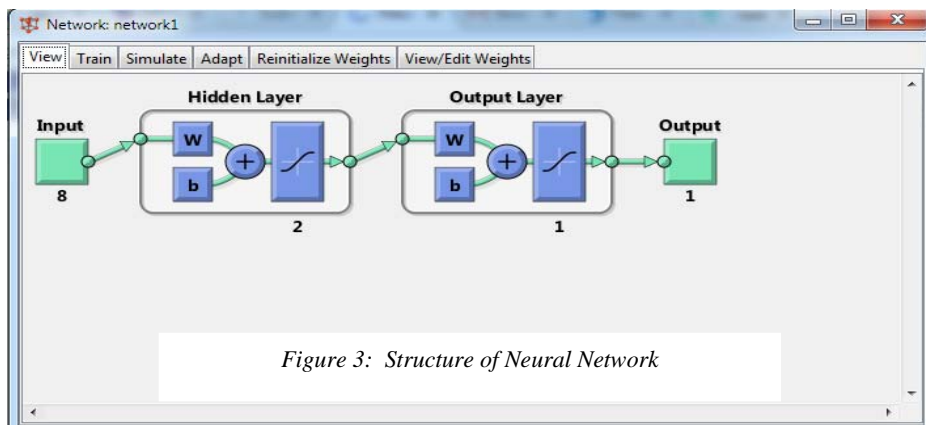


Figure 3: Structure of Neural Network

Islamic sciences	Arabic language	English language	Social sciences	Mathematics	Biology	Chemistry	Physics	output
1	0.809462587	-0.230973745	-0.1112	0.4076	-0.2592	0.3334	-0.493186	-0.2
1	1	-0.172925667	0.2942	1	0.5882	0.5294	0.1057331	0.6
0.881638164	0.255592697	-0.616705439	-0.1516	-0.0324	0.0344	0.4074	-0.772791	-0.2
0.830333033	0.514785292	-0.491303866	-0.3334	0.1836	0.125	0.102	-0.769502	-0.2
0.918091809	0.532527642	-0.922897973	-0.132	0.6924	-0.0944	0.4902	-0.522556	-0.6
0.356885689	-0.077140653	-0.80015509	-0.303	-0.25	-0.2666	-0.1804	-0.71875	-1
1	-0.131396246	-0.240722278	0.36	0.6668	0.4166	0.6666	-0.003524	0.6
0.881638164	0.661609668	-0.676747535	-0.2106	0.7896	0.4594	0	-0.202303	-0.2
0.867686769	0.77320648	-0.303201507	0.2352	0.6472	0.5758	0.7058	0.3132049	0.6
0.785778578	0.285677552	-0.807909605	-0.3934	-0.5872	0.1428	-0.371	-0.862782	-0.6
1	1	-0.27572837	0.6364	0.8788	0.6364	0.8788	0.4325658	0.6
0.836183618	0.719465158	-0.087626011	0.2728	0.2728	0.309	0.4444	-0.191964	0.6
1	0.298791463	-0.006979063	0.2728	-0.2728	0.4546	0.5454	0.21875	1
0.015751575	0.585240422	-0.592334109	0.0626	0.1252	0.6876	0.5	-0.248355	0.2
0.590909091	0.415530985	-0.510579373	-0.2222	0.4284	-0.0526	-0.3	-0.828712	-1
1	1	0.169159189	0.75	1	0.875	0.625	0.0453477	1
1	0.951401389	-0.003212584	0.6982	1	0.8114	0.8076	0.3639568	1
0.865436544	0.34764721	-0.557771131	0.3334	0.6364	0.5334	0.375	0.0291353	1
1	0.92208794	0.160740002	0.6666	0.6364	0.8484	0.8788	0.4325658	1
1	0.959115454	0.24958458	0.8096	0.492	0.5238	0.8412	0.4765038	1

Figure. 4: Normalization Process

$$O1_j = \text{TANH}(S1_j) \quad (3)$$

$$S2_k = \sum O1_j w_{jk} \quad (4)$$

$$O2K = \text{TANH} ( S2K) \quad (5)$$

$$X_n = \frac{X_{max} - X_{min}}{X_{max} - X_{min}} - 1 \quad (1)$$

There are many types of transfer functions used in the neural networks. The important types are sigmoid, linear and TANH. The mathematical expressions of the output equation are generated using simple regression of neural network that listed below:

here, i: input layer nodes = 1,2,3...,9 ,10. J: hidden layer nodes = 1, 2, 3, 4, ...12, 13. k: output layer node =1.  $I_j$ : Inputs. b: bias.  $O2_k$ : The calculated outputs. Training weights:  $w_{ji}$  and  $w_{kj}$  as shown in Table 1.

$$S1_j = \sum I_i w_{ji} + b \quad (2)$$

Table 1 : Training weights

Inputs	Weights and bias from Input (I) to Hidden (H) layer		Weights and bias from Hidden (H) to Output (O) layer	
	H1	H2	H1	H2
I1	0.3518	-0.37865	2.1032	2.1513
I2	-0.43004	-0.21483		
I3	0.45531	0.54051		
I4	-0.21968	1.1268		
I5	0.21244	-0.23864		
I6	-0.043744	0.55476		
I7	-0.57945	1.3608		
I8	1.7852	-1.2129		
Bias	-0.16807	0.65879	Bias	0.10727



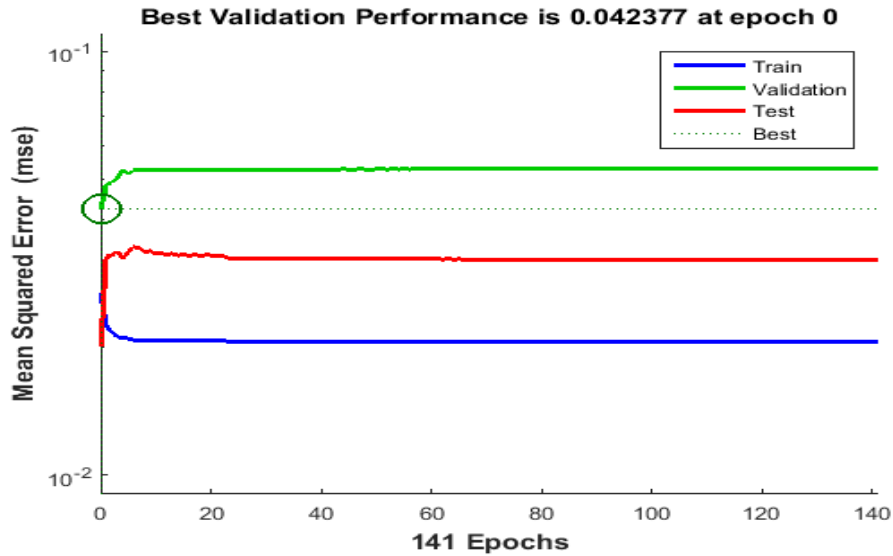


Figure .5: Best of Performance Model

One of the occurring problems in the training of neural network is called over-fitting, which happens when the model is extremely complex, like having more parameters relative to a number of observations which leads to the poor performance in prediction. In our research, no significant over-fitting existed because we got the best validation performance in the proposed network structure as shown in Figure 5.

**4.2 Neural Network Models Equations**

By using the weights, biases and the transfer function in the proposed network structure were showed in the Table 1. The predicted of the

success rate in middle schools can be calculated in the following equations:

$$\text{SUCCESS RATE} = 2.5 * \text{TANH}(X1) + 5.5 \tag{6}$$

Where:

$$X1 = 2.10 * \text{TANH}(H1) + 2.151 * \text{TANH}(H2) + 0.107 \tag{7}$$

$$H1 = 0.0158 \text{ Islamic} - 0.0110 \text{ Arabic} + 0.0100 \text{ English} - 0.0043 \text{ Math} + 0.0084 \text{ Sociality} - 0.0008 \text{ Biology} - 0.0115 \text{ Chemistry} + 0.0419 \text{ Physics} - 3.3497 \tag{8}$$

$$H2 = -0.0170 \text{ Islamic} - 0.0552 \text{ Arabic} + 0.0119 \text{ English} + 0.0225 \text{ Math} - 0.0095 \text{ Sociality} + 0.0111 \text{ Biology} + 0.0272 \text{ Chemistry} - 0.0284 \text{ Physics} + 0.8858. \tag{9}$$

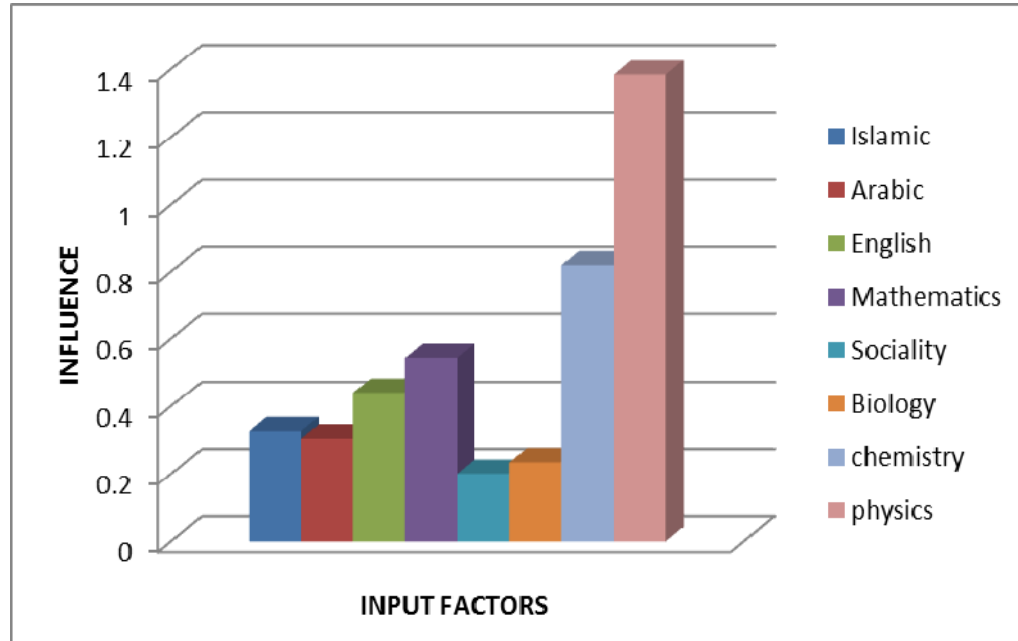


Figure 6: Impact of Input Factors on Success Rate system

#### 4.3. Sensitivity of Model

In this paper, we applied the Garson technique to find any of the inputs have more impact on the success rate in the intermediate schools. This technique involves the relative significance of the eight subjects input marks, including the examining input and output weights of the network. Thus, this technique can detect the inputs with highest impact on the success rate. Figure 6 depicts the success rate versus the input.

As shown in Figure 6, Physics subject has the highest impact on the success rate, followed Chemistry, Mathematics and English subjects, respectively.

#### 4.4 Validation of the Model

The inputs must be investigated to verify suitability the proposed model. Physics and Chemistry are selected because of their greater influence on the success rate after application of Carson technique which observed in Figure 5. The followed values of success rates were assumed for physics and chemistry subjects are (10%, 50%, and 100%) and applied to the

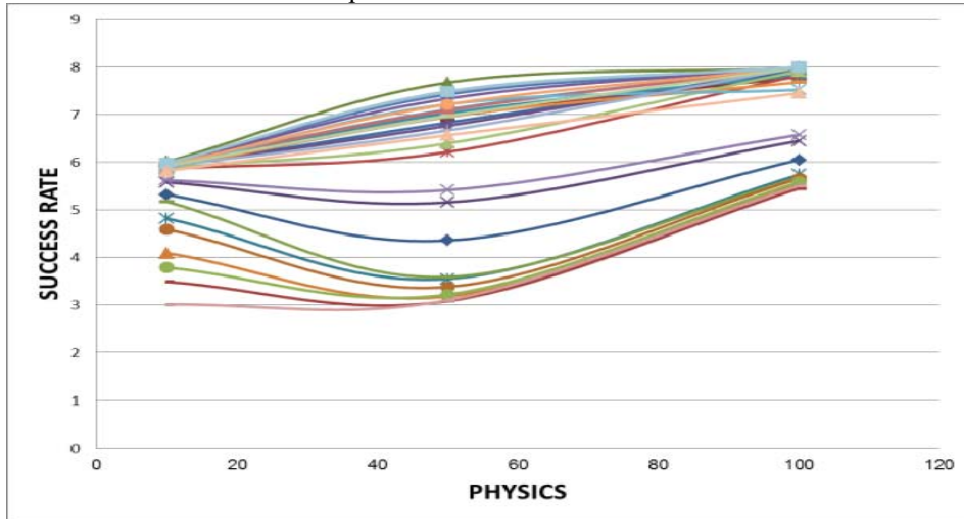
equation of the success rate that obtained in the proposed model as shown in Figure 7. After

applying equation 6, Figure 7 showed increase in the success rates after using 10%, 50% and 100% which applied respectively. This increase was ranged from 5.3%-7.4% in case of Physics subject and from 3.03% to 7.6% in case of Chemistry subject. This achievement is considered a real indicate for the obtained equation; therefore, the proposed model is acceptable to measure the success rates of any school as well as success rates of the universities. Hamza and Kareem [21] referred to use physical laboratories to have practical skills and development of the experimental work in physics for understanding and facilitating the studying in other subjects.

The neural network is considered the prediction engine of our proposed model, which consists of three main stages: Training, Validation, and Testing. In the Training stage, the network parameters, optimal weights, and network structure that will be fed as inputs to the Testing stage. After training of the inputs and get the optimal weights, we have achieved overall prediction of the success rate of 95.161% after 141 iterations. The number of hidden neurons of the neural network has been chosen ideally to avoid over-fitting. then these optimal weights are fed into testing stage. One of the benefits of the neural network is the acquisition of a regression plot, which it means measuring the performance of the trained network by measuring errors in the

training, verification and testing stages by analyzing the network outputs and targets. If the network training is excellent, the network outputs and targets will be close to equal. Figure 8 represents the regression plot of basic stages. A deep insight in the in Figure 4, the dashed line means the ideal result i.e. the outputs of the

between the output of the network and the targets i.e. an accurate linear relationship and this is what happened in the model proposed where R in all stages above 95%. This ratio is considered a perfect result to predict on success rates.



networks equal or close to it targets and the solid line means the best fit linear equation between that outputs and targets. The correlation-coefficient (R-value) , it is a measure of the difference between network outputs and targets, if the correlation coefficient (R) is one or close to one that means there is an ideal relationship

### 5. CONCLUSIONS

This paper contributed to predict the success rates for intermediate schools in Anbar province, Iraq after the neural network was trained and

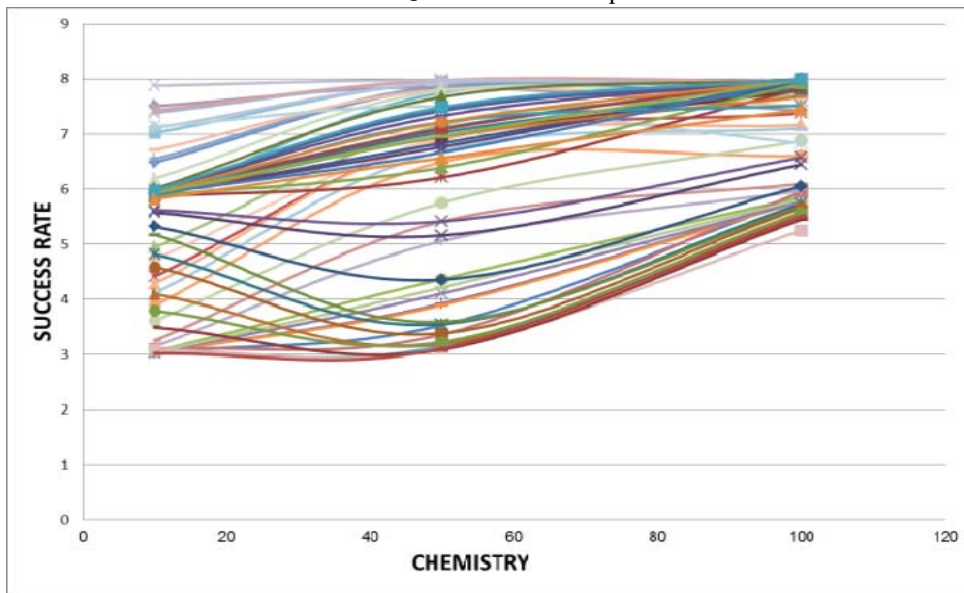


Figure 7 : Impact of Physics and Chemistry Factors on Success Rate system



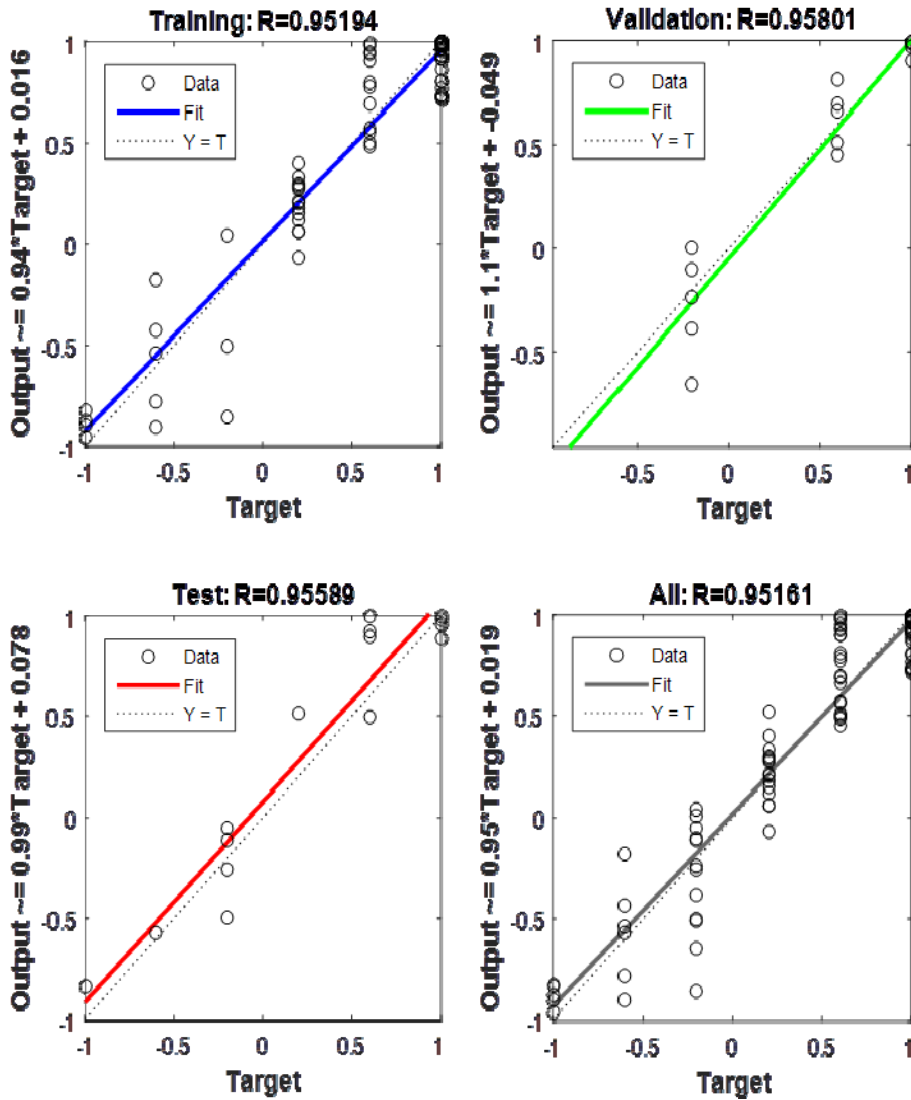


Figure 8: Regressions of Model between Outputs and Targets Predicted Success Rate

tested results of 100 schools, we get regression more than 95%. This percent proves the superiority of the neural network on traditional methods of prediction. Depending on the high predict which was achieved in this paper we recommend using another data to predict the success rates such as universities or any other educational institution or applied this model to predict other applications such as oil prices, sales volume of the medical product, economic growth, currency exchange rates, etc.

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