Pathology and Prediction of Performance of Virtual Students by Using Regression Techniques

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Abstract

E-learning (virtual learning) has become a very useful way to educate people around the world. Due to various reasons, people are unable to attend classes in person and take advantage of face to face training. Because in today's world, one of the very basic human needs is the education and scientific and non-scientific understanding of science, for residents of remote areas, employed people and all people who are able use lectures and versed professors in urban and rural areas or due to work cannot attend regular in-person meetings, remote or so-called virtual learning program is very important. One of the major challenges in e-learning is checking the rate of progress and finally the evaluation of performance of virtual students who were trained in virtual systems. In this study, using data mining techniques (regression) method, it is tried offer a method to predict academic performance of students in virtual training are learning.

Keywords:

E-Learning, Distance Learning, Academic Performance, Data Mining Techniques, Regression, Neural network

1. Introduction

Nowadays, the need to take advantage of a variety of science and technology has become one of the most basic human needs around the world. Moreover, life issues, expensive commute to attend in-person meetings for education, lack of access to skilled teachers in rural areas and many other reasons have caused many people to turn to distance learning or e-learning. In its simplest definition, distance education is called to a kind of education in which there is a physical distance between teacher and learner and all or most of the communications are made through an electronic/printed artificial interface. Knowledge transfer has experienced an evolutionary process in this modern system. It requires benefiting from modern communication and information technologies such as internet and multimedia systems as means to improve the quality of education through providing the required facilities for easy access of educational resources and services and providing the mechanism for distance cooperation and interaction.

Many learning management systems have been proposed and used in many institutions and universities. These systems are able to provide many services for students who wish to use them to learn science and to some extent can monitor all their activities, but the biggest challenge in using this type of education was the inability to predict the performance of students accurately.

Data mining is the science that by using its scientific techniques tries to create patterns and then uses these models to explore the knowledge as well as to predict its future conditions. Now, in all scientific fields such as business, education, meteorology, geology, medical and so on data mining is used for prediction. Two important tasks of data mining include describing the tasks and duties of the prediction. In this study, we will use its prediction use. Using regression techniques, we will try to provide a method for predicting the performance of students trained with virtual methods.

This paper is designed in five sections. In the second part of the learning and data mining concepts will be explained briefly. Literature is mentioned in Section III. Section IV describes the proposed method and in the fifth we will talk about the practical results obtained and the sixth part is the conclusions and future work. This paper has been drawn up in seven chapters. In Chapter 2, general concepts of virtual education and data mining will be explained in brief. Research background has been given in Chapter 3. Chapter four of this paper deals with explaining the recommended method. Chapter 5 has discussed the scientific results and chapter six deals with data analysis by using MATLAB Software. Finally, conclusion and further researches are given.

2. Key Concepts

In this section, some of the concepts used in this paper are briefly explained.

2.1. E-learning

Today, enjoying the virtual space and the use of efficient technologies of the communication world for human societies have become a necessity. The creation of a virtual world alongside the real world has mostly influenced universities. In this new system, different countries, according to local, social, and cultural circumstances and poverty have benefited from it. Today,

we witness the creation of virtual universities and institutions offering different disciplines [1]. Virtual classrooms are a new form distance learning that by new ways of using modern communication tools and communication technologies makes it possible for all learners to have access to classes from anywhere in the world at any time, and in the presence of any problems or questions contact with the professor, and ask their questions or express their opinion. This system is an online virtual environment where students and teachers are connected with each other. This environment simulates a typical class facilities such as video conferencing systems and multimedia [2]. Now, with the appearance of universities, virtual education centers require students no longer to leave home and have travel and accommodation costs and anyone at anytime, anywhere can use this facility. In addition, start and end hours are not fixed and students attend class at any time, of the advantages of virtual learning environments is training that is essentially influenced by normal learning. Periods can be tailored to individual needs, preferences, and offer students a single, more comprehensive training plan. The nature of telecommunications and asynchronous communication allow students to think about it and put their "knowledge" more effectively and transfer learning before answering questions, of other functions of virtual learning is digital libraries that the university centers have provided for their students and the students can have the books without time limit. One of other functions of virtual education is to benefit from digital libraries that have been provided by universities for students, providing the students with books with limitation for time and keeping the said books [3].

2.2. Data mining

Data mining is a science to discover interesting, new, applied information out of a large mass of raw data. Data mining processes are visible in Figure 1.
As can be seen, data mining has the following steps:
Collecting data by different methods such as interviews, surveys and registration forms distributed by observing their actions and activities of individuals to collect raw data.
Choosing traits: the collected data may have many dimensions and to be able to obtain our desired pattern, we do not need to use them all, so at this stage we select the required characteristics.
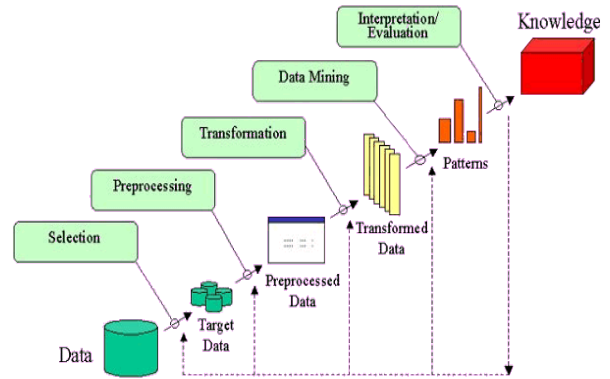

Figure 1. The process of data mining [4]

Pre-processing: In this phase, data is cleansed and acts such as the removal or placement of records with blank fields is done. Normalization is also done in this phase. At the end of this phase, data are ready for processing.
Converting data: To do any technique, we need a certain type of data, for example, to work in Rapid miner, we need to save the data in Excel format and for regression data type should be numerical, in this part, data changes, and data conversion is done.
Apply data mining techniques: according to our purpose functions such as clustering, classification, discovery and community relations, and regression and so on are performed on the data.
Gain the Model: after applying data mining, a technique (model) is created for data that can be used to predict the new conditions.
Evaluation of the model: to ensure the accuracy of the model, we carry out some experiments stored under the test set.
Gain knowledge: from the patterns and association rules obtained, we will proceed to discovery of new knowledge and will display them in accessible and understandable formats to the user such as tables, diagrams and so on [5].

2.3. Neural network

Learning is a process in which the neural network changes it parameters in a way that best simulates environments. In neural networks defined change processes of weights over time results in learning. For machine learning, knowledge representation, and finally applying, the knowledge gained predict the output response from complex systems. The main idea of such networks function is inspired by biological nervous systems for data processing, data to learn and create knowledge. Key element of this idea is to create structures for information processing systems. The system consists of a large number of processing elements called neurons, which are extremely interlinked with each other and acts to solve a problem.

The main role of a biological neuron is the act of summing up its inputs to the extent that the inputs do not exceed the point called threshold and then produces an output. Input neurons enter through the dendrites of other neurons that are plugged into output by points (synapses). Synapses change performance signals. Body cells receive all inputs and when the total input signal exceeded threshold a signal is triggered.

The model made from neurons must have the following characteristics that are briefly:
• Output depends only on inputs. The inputs should be enough to activate the output neurons.
• Output of a neuron is active (one) or inactive (zero).

The efficiency of synapses in transferring input signals to the cell body can be modeled by using the transmission coefficient multiplied by the input neurons. Stronger synapses that transmit more signals have a much larger coefficients while weak synapses have smaller coefficients [6,23].

2.4. Damages and opportunities of evaluation of virtual education

Some of damages of evaluation of virtual education at e-universities and opportunities created by communication and information technology are mentioned.

2.4.1. Capacity Building damage

Various efforts should be made across the educational system for capacity building. It is necessary for specialized progress of professors, proper capacity building should be conducted. The said capacity building can be implemented in form of five pivots:

1. Skills in specific applications
2. Merging in existing curriculums
3. Changes in curriculum in connection with application of IT
4. Changes in role of professors
5. Support of educational theories

According to the research conducted, communication and information technology puts forth incapability of professors that hinder their success regarding various education fields in many years and on a steady basis.

2.4.2. Training Injuries (Pedagogy)

They are originated from new conditions in virtual environments, new target groups and new goals in such a manner Derifus stated that virtual educational environments have separated students from the place of education and created obstacle on achievement of knowledge in university environment. In e-education system, lecture should be used and due to quite clear and obvious reasons, the goals achieved through lecture delivery should be estimated in a quite fresh way. Further to face-to-face interview at conference hall, professors and students should facilitate education and facilitate through fresh methods.

2.4.3. University Damages

University damages refer to the conditions that correspond to the framework required for e-education activity. These damages are related to development of libraries, education management and consultation for students, gathering the instructors and other merited personnel and establishment of a fresh framework for development of new training. For development of e-education, libraries should be seriously studied in such a way that students should become sure that they will access libraries. In this regard, adaptation with e-education can be based on at least two different strategies:

1. Increase of working hours of management unit or high level of e-assistances by the person himself
2. Asynchronous question and answer

2.4.4. Technological damages

It is quite clear that technological issues are essential in e-education. Thus, technological damages are divided into three relevant processes:

1. Selection and development of proper technology
2. Application of technology
3. Technological operation

These technologies comprise certain means for support of learning processes and education management. It should be noted that technology should be selected by considering the educational framework and it must be reliable and used easily.

3. Related Works

Increasing development of information and communication technology (ICT), intentionally or unintentionally, has influenced all aspects of our lives and we are getting more and more affected by this phenomenon every day and see the great potential of this technology, its speed and power to obtain, process, use and transmit information [7]. (Pavlvsks, 2006) Sprrat [8] using a linear regression model examined the impact of e-learning on student performance and showed that the use of e-learning increases the efficiency and improves the performance of students. Cronbach's alpha was used to test reliability.

Davis [9] studied the impact of online transactions and e-learning on educational performance of students in a particular course, at the end of the year and in the end, to examine the impact of their online interactions on their performance used statistical analysis and hypothesis

testing. The results showed that there is no significant relationship between the online interactions and class rank. Galli and colleagues [10] investigated the effect of online and electronic education on campus on the performance of students. They evaluated the performance of in person students and the ones in virtual training system. To do so, they used statistical analysis and T-test. Barker and Wendel [11] examined the impact of virtual learning environment of students in Canada. Using a questionnaire, they extracted students' opinion in relation to the impact of virtual education system on the learning of the students. Wang [12] examined the attitude and thinking of freshmen of accounting towards virtual learning. He examined two variables, virtual tutorials, and teaching materials available on the Internet. He also evaluated the performance of students according to their grades. Ahad and colleagues [13] investigated the effect of virtual education on the performance of the students. The variables include the method education, personality traits, mental and spiritual well-being, and educational achievements. In this study, correlation analysis is used to determine the impact of academic performance on each of the factors listed for students' performance in virtual learning system. Spooner and colleagues [14] compared the grades of students in two virtual and campus educational systems. They extracted information about the two lessons of the students and using statistical analysis and hypothesis testing, they attempted to find a significant difference between the scores, but they could not find a significant difference. Cheong [15] suggested a framework based on statistical analysis and statistical hypothesis testing, to evaluate the effectiveness of the system of distance education. The method proposed by him has four main aspects of student progress, assessments, teaching materials and communication and on the number of criteria intended to measure. Jakovich [16] stated the guidelines for creating an effective environment for electronic training. The study is divided into two phases. In the first phase, it is attempted to provide a general framework for the creation of e-learning space. In the second phase, using data related to 40 learner, three teachers were evaluated. In this study, the experience is assessed. Analyzing the documents and interviews takes place through focus group.

Zielezinski [17] et all studied the effect of e-education on performance of students. In their research, they used the linear regression model. It has been shown that use of e-education results in promotion of efficiency and improvement of performance of students. Moreover, in order to study the effect of e-education on students, a questionnaire with a statistical population of 300 persons have been used. Woda [18] et al studied the existing obstacles for collaborative e-educations. They have divided the said obstacles into organizational and structural obstacles, technological obstacles and existing obstacles in education. In order to conduct the said research, they have used a questionnaire for data collection and studied the said data by use of statistical analysis through MATLAB Software.

In 2005, a specialized service in integrated e-education based on the module of educational management system (LMS) was introduced. The said e-education system is an environment where educational plans are presented. Use of the said software by trainees for education and learning during the period when they attend the network is more similar to arrival of students in a class. Using LMS, students choose their credits and subjects and complete the drills and sat for prescribed examination and also communicate with professor and other students as well [19].
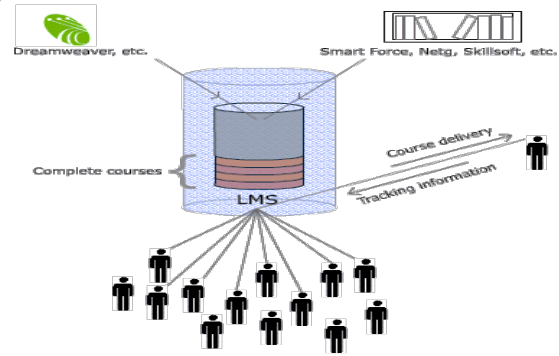

Figure 2. A model for LMS

4. Proposed Method

In this article, by getting help from neural network approach, it is tried to examine the factors affecting the performance of virtual university students. In this section, we discuss the method used in this research.

The study population consists of all faculty and graduate and PhD students, which is equal to 5,000 people. Because of extensive research community on one hand, and on the other hand, since the number of subjects is limited, to determine the minimum required sample size, Cochran's formula is used, which is as follows:

$$n = \frac{NZ^2 P(1-P)}{d^2(N-1) + Z^2 P(1-P)}$$

$$n = \frac{(1000)(1/96)^2(0/5)(1-0/5)}{(1000-1)(0/05)^2 + (1/96)^2(0/5)(1-0/5)} \approx 277$$

In which:

n = minimum required sample size

N = size of population

p = ratio of the distribution of property in the community

za = value obtained from the standard normal distribution table (in this study and by considering the amount of error of 0.05, the obtained value derived from the standard normal distribution is 1.96.

d= error accepted by the researcher or a tolerable range of parameter estimates (usually considered to be 0.05 in Social Sciences) [20].

The purpose of validity is to see whether the instrument measures what it is designed to or not? In other words, validity determines how much the instrument measures a particular concept. The validity tells us whether we examine the real meaning of what is desired. The issue of validity is important because wrong and inadequate measuring can be worthless in scientific research [21].

The purpose of reliability is to see if the research is done by another person or by the same researchers in different times and places will give similar results. To calculate the reliability coefficient of the measuring devices, various methods are used that include: rerun, parallel method, Cronbach's alpha coefficient (for questions or multiscale parts) and Kuder - Richardson formula (for planar questions) [22].

In this study, Cronbach's alpha method is used to estimate the reliability of the survey instrument.

Inferential statistical methods used in this research are:
• One-sample t-test
• ANOVA and Tukey tests

We have used Kolmogrov-Smirnov test to determine normal and abnormal use of data and using one sample t-test, the attitudes of students and professors of Islamic Azad University about barriers to academic performance of electronic unit students have been dealt with.

5. Experimental Results

In this study, 211 students and professors of electronics unit of Islamic Azad University were tested using the questionnaire. The result of description of their gender is given in Table 1.

Table 1. Number and frequency of individuals in sample

Gender	Frequency	Percentage
Female	106	52.2
Men	105	49.8
Total	211	100

The range of age of individuals is given in Table 2.

Table 2. Characteristics of the subjects

Age	Number (frequency)	Frequency (Percent)
25-30	15	7.1
31-36	159	75.4
Upper than 36	37	17.5
Total	211	100

The survey of the educational level of the participants was 183 (86.7%) MA, 18 (8.5%) people PhD students, and 10 (4.7%) professors. Of the total participants, 134 (63.5%) were single, and 77 (36.5%) were married.

Before using t-tests, first we must ensure the normal distribution of variables. To test normality of components Kolmogorov-Smirnov test is used that is a nonparametric test

To investigate the reliability, the questionnaires were given to 30 participants of the study population that after testing their reliability and using Cronbach's alpha value analysis and using SPSS software were obtained as follows:

Table 3. The reliability of the questionnaire

Row	Components	Number of questions	Cronbach's alpha
1	Organizational	10	0.850
2	Culture	2	0.882
3	Education	4	0.867
4	Management partnership	5	0.850
5	Manpower	1	0.861
6	Performance	1	0.875
Total Questionnaire		23	0.884

Then, several variables (including organizational, culture, education, participatory management, human resources) were elected the results of which are shown in Table 4.

Table 4. Statistical results obtained for the selected variable

Variables	Number of questions	Mean	S.D.	Max	Min
Organizational	10	3.08	1.06	1	5
Culture	2	3.28	1.04	1	5
Education	4	3.15	0.917	1	5
Management partnership	5	3.25	0.939	1	5
Manpower	1	3.30	0.989	1	5
Total	22	3.23	0.908	1	5

Table 3 scores show that the highest and lowest averages were related to human resources and cultural variables (3.30) and organizational (3.08). It should be expressed that all indices are above the average theoretical value (3) in the questionnaire, closeness of values to each other is also considerable.

Before using t-tests, we must ensure the normal distribution of variables. To test normality of components Kolmogorov-Smirnov test is used that is a nonparametric test. Calculating the statistic of this test is possible using SPSS. If the value provided by this test statistic is greater than 5%, statistical null hypothesis of normal distribution of variables studied is accepted by 95%. The results of the normality test of variables are shown in Table 5. As visible in Table 5, the results of Kolmogorov - Smirnov showed test that as the level of significance for all

variables is more than α=0.05, so H0 is located in the area, and normal distribution of data is approved.

Table 5. Results of Kolmogorov – Smirnov test

Variables	Statistics	Sig
Organizational	1.626	0.062
Culture	1.627	0.059
Education	1.360	0.213
Management partnership	1.964	0.512
Manpower	1.626	0.062

6. Data Analysis by using MATLAB Software

6-1. Data Analysis with Neural Networks

At this part, the research results are studied in form of neural networks. For calculation at this part, MATLAB software has been used. The results are reported based on the format of the said software.

6.1.1. Dual layer Neural Network

At this part, double layer neural network is discussed. Network 1 has been designed in form of Double Layer with 22 inputs and 1 output and five neurons in the first layer.
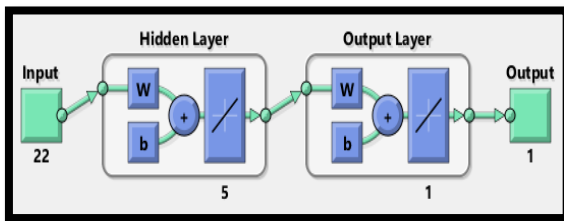
Figure 3. Diagram of Double Layer Neural Network with Five Neurons

First, we have taught the network for data corresponding to professors. The said data consists of 10 items. In fact, we have ten inputs. Instead, there are ten outputs.
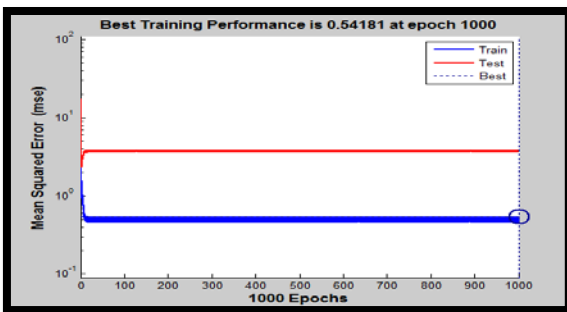

Figure 4. MSE Diagram for data of professors

Network has been trained with 1000 repetitions with a great number of repetitions. In this network, number of data divided among test data, education and confirmation should be given as 3, 2 and 5 respectively that has been

divided by the software itself. In fact, the said network has been taught with two data which are quite few and unreliable. R2=0.014. This figure shows that this network cannot be relied by any means. Actually this figure indicates that only 1.4% of the relationship between independent data is described by the dependent variable that is a very small figure. Thus, data of this network with quite few numbers of input cannot be relied either.

Thus, all data are collected and the said network is taught once again. For total data we use the following formulation. Transmission function is linear and education function, by using semi-Newton method for minimization of squares is error. After thirty rounds, the following results are obtained:
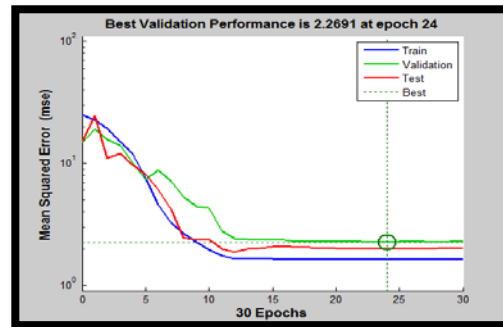

Figure 5. MSE Diagram in Double Layer Network

In the aforesaid figure, the best value of operation evaluator (minimum squares of error) in performing education rounds for training data and test data have been shown.   R2=0.614 that is a more desirable number compared to network education only by ten data and it enjoys an absolute priority over the network of professors and its data is reliable.

Education condition of this network has been shown in the following diagrams. The first diagram shows the changes of Gradient during education period. The second diagram is for assessment and validation revealing to what extent the respective data is located compared to actual (target) data per each round of education.
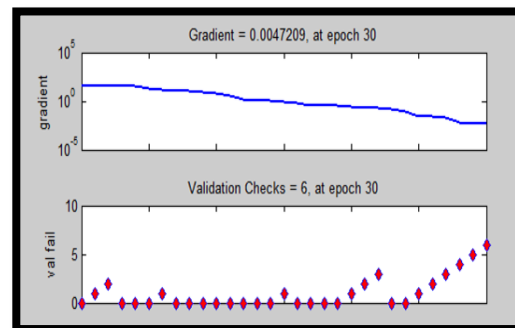

Figure 6. Diagram of Gradient Changes during Education in Double Layer Network

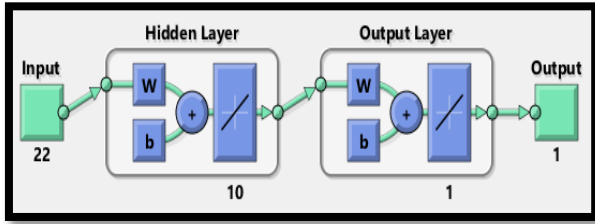Now, we analyze the network with two layers and 10 neurons:

Figure 7. Double Layer Neural Network with Ten Neurons

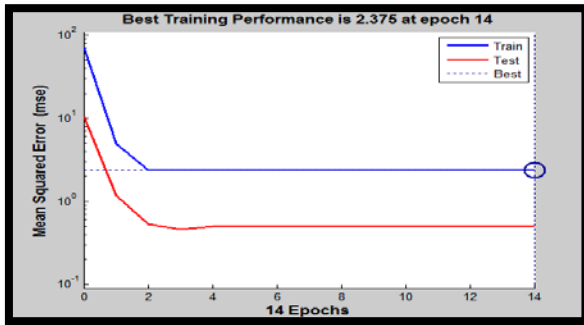The said trained network by data of professors is given as follows:

Figure 8. Ten-neuron network trained by data of professors

In this network, both MSE and R2 are in more awkward position compared to data accumulation. The value of R2 =0.091. It means 9% of relation by this network and the said network and its data are not acceptable by any means. Thus, data in this network should be collected.

Training the said network, the following outputs are achieved. After 24 rounds of training, we have.

As it is shown in the above diagram, upon increase of number of neurons, the value of MSE has been improved and reached to its utmost value in the 18th round and achieved less values in other part of the model in less number of rounds. R2=0.86. Consequently, the results of the network are reliable.
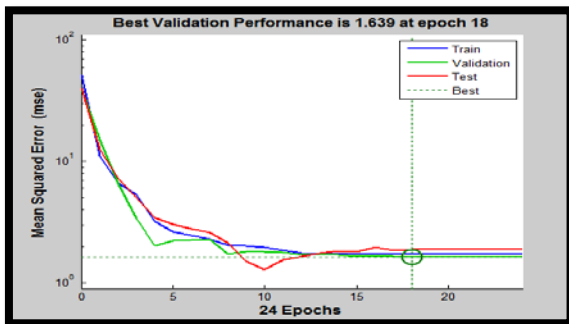

Figure 9. MSE Diagram at Double Layer Network with Ten Neurons
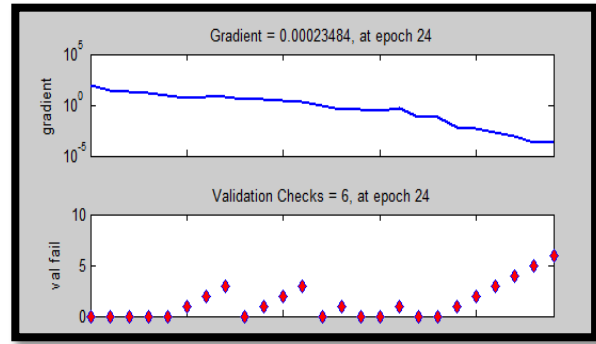
Training stages are given as follows:

Figure 10. Diagram of Gradient Changes during training of Double Layer Network with Ten Neurons

6. Conclusion

In this study, we tried to investigate the factors affecting the performance of the virtual training system. Factors that impact such systems often follow nonlinear equations. In such circumstances, to investigate a model that can measure the impact of these factors artificial neural networks were used, and using SPSS software, the attitudes of professors and students were discussed.

The results obtained from methodology showed that in attitudes of professors and students of electronic unit organization, culture, education components, the elements of participatory management and human resources components are effective on the academic performance of students of electronics unit of Islamic Azad University. Corresponding information has been collected through the questionnaire and it has been tried to consider different aspects. These aspects comprise hardware infrastructures of the organization through cultural elements. The results of this research have revealed what neural network with what structure is preferred and it can explain the relations among the elements. A summary of comparison of these networks are given in the following table. In fact, it is the best result achieved through this research.

In this research, two questions were propounded that have been studied based on analysis through use of artificial neural networks. The reply to the said questions in this research is given as follows:

Question 1: Which are the elements of use of virtual education at universities?

The most significant elements affecting the use of virtual education have been analyzed in form of 22 strains by using the questionnaire. Considering the statistical table presented in Chapter 4, it may be stated that organizational infrastructure elements especially information technology substructures and cultural elements are seriously effective in use of virtual education at universities.

Question 2: What is the pathology of use of virtual education at universities?

In this research, it has been tried to use a neural network in order to study the exiting relations on the elements of use of virtual education and its effect on performance of students. This pathology has led to identifying two important elements from among twenty two elements that are studied. These two elements are namely organization infrastructure of information technology and cultural elements. Consequently, development of virtual education system depends on development of infrastructures of information technology and promotion of culture of virtual education in Iran.

The results obtained from methodology test presented reveal that from the viewpoints of students and professors of e-branches, the elements of organization, culture, the elements of education, collaborative management elements and human resource elements are effective on educational performance of students at e-university.

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