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APPLICATION OF NEURAL NETWORK MODEL FOR ANALYSIS AND EVALUATION OF STUDENTS Individual DIFFERENCES

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ABSTRACT

This work belongs to a novel research direction adapted to Artificial Neural Network (ANN) technology with cognitive - emotional Interactions of educational technology. That research direction, is basically adopted for the study of fundamental design principles required for solving some educational issues. So, interpretation and prediction of cognitive data associated with brain function and students' interactive behavior during learning/teaching process have to be well studied. In other words, the combination of both ANN and educational technologies motivates, and supports well, the new research studies planned for by solving for some critical problems related to learning/teaching process.

In this paper, the analytical results obtained from computer simulation for education measurement are presented. These results given herein, were carried out though the design of a realistic Feed Forward Neural Network (FFNN) model simulating both of teachers' and students' behaviors in our classrooms. More properly, the problems that observed due to individual differences of learning students' level and their response performance were considered. Interactions of students' and teachers' response performance is evaluated using a MultiLayer Perception (MLP) as an ANN model trained by back propagation of errors under supervision (With a teacher). The relation between the desired and obtained outputs of the MLP model is used to measure the response performance of learning process. The mean value of relative errors obtained, and the variance value of this error is computed, for comparison of teachers' ability, and students' response considering individual differences. Thus, the obtained results include computations, that many times repeated to illustrate the learning processes individualities they carried out for four teachers and nine students different groups (each includes eight students).

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The paper is organized as follows. At the next section, an introduction is given that to show how the new approach of ANN models applications in educational technology is acceptable and realistic. In section II the suggested ANN model description is briefly introduced. The obtained analytical results and some comments are shown at section III in four numeric tables and four graphical figures. Finally some conclusive remarks are given at section IV.

KEYWORDS

Artificial Neural Network, Educational technology, Education measurement, and Individual differences.

I- INTRODUCTON

The issues of education measurement for learning/teaching process analysis have been studied for a long period of history, through the classical field of education, since 1920 [1]. Naturally the individual difference factor associated with performance levels of students has been proved to be very effective while tackling such problematic educational issues. As an example, this factor has been shown to be of great and direct impact on the education measurement processes; when dealing with its evaluation and analysis, considering various psychological environmental conditions effecting to the under tested groups of students, [2-4].

The introduced approach herein deals, with such issues by combining the biological information processing (neural networks) technology with the cognitive emotional interactions of learning/teaching process, [5-7]. That approach seems to belongs well to one of the two types of theoretical activities related to the field of biological information processing adopted by the Center of Adaptive System (CAS) in Boston university. These two considered types of (CAS)'s activities are given by Stephen Grossberg as "One type of activity studies the fundamental design principles and mechanisms needed to explain and predict large data bases about brain and behavior. The other type of activity generates Novel architectures for implementation as intelligent machines in technological applications." [8]

Recently, in 1994, two research works were published dealing with that combination of neural network technology (ANN models) with some of the problems observed in the classical field of education [9], [10]. These two papers considered two issues: the learning process using noisy teachers, and learning ability of students respectively. That, while considering deferent initials environmental conditions before starting teaching/learning processes.

More recently, in 1997 some work that somehow related to our adapted approach is presented, at [11]. That work was showing how neural network models may be applied to improve some of classical teaching processes in agricultural education. Nevertheless, the presented work herein seems to modify the two mentioned works [9], [10] in the above. The Suggested model belongs to that class of learning with a teacher. On the contrary with the noisy teacher model shown at [9], the modified model structure is similar to that given at [10]. The internal steady state of the suggested model (weight vectors), used to simulate thc teaching ability state rather the brain state of students, as in[10]. Moreover,thegroups of students with individual differences were presented as sets of input data vectors. Thc output of the suggested model represents the answer of any students.

The learning process of the suggested model is based on the famous technique using the error of back propagation (learning with a teacher). The relative error between the desired and the actual obtained output-of the given model- are considered to measure any of the teachers' teaching ability. More properly, the effect of individual difference at the end of teaching, process (for any/all of students group) is presented according to the evaluated nature of the obtained relative error. The simplified ANN model description and its function are given briefly at basely the next section.

II- MODEL DESCRIPTION

The suggested model is exactly the same like that presented for publication most recently at [12]. The model presented therein is motivated by some of obtained results of the two published works. These works are related to the application of neural network modeling to solve some mechanical engineering problems, [13], and [14].

As a simplified description of the considered model herein, it is a multilayer perception with four, nine, and one neurons. The neurons are distributed over the three input, hidden and output layers respectively. The basic structure of the model is given at fig. 1. The model follows the theory of mapping functions introduced by Kolmogorov,[12], that shows the MLP capabilities and described in [15],[16]. The model is intentionally designed after [12] to simulate the interactive learning process, observed between one of student group and his teacher. The process is repeated many times according to the available under testing students' groups (nine). Obviously, the objective of this process is the transference of some experience of any teacher to the considered students' groups. As in nature no ideal teacher is practically exist [9], the set of weights that presents the teacher ability were given at various four ranges (-0.5~0.0), (-1.0~0.0), (0.0~0.5), (-0.5~0.5) of weights proved to have certain effect on the learning process convergence as shown by the results obtained at [10].

This experience is stored everywhere through neural network interconnections that simulating the brain state of the experienced students' groups. As a realistic assumption for this model none ideal (noisy) teacher is considered the chosen for sets of weights herein simulate global brain state of all groups (each set represents different teacher). The reached brain state of these groups is simulated by a random set of weights. These states are assumed to be reached due to the transfer experience. The output response (answer) of the brain state model (at the output signal neuron) is obtained spontaneously when any of the input vectors (students) is applied to the input layer (four-neurons). This mechanism seems to be similar to the learning by interaction with the environment, [17]. The response of each students' groups is evaluated through the results obtained in four-numeric tables and illustrated by four-graphical figures introduced at the next section.

III- RESULTS AND COMMENTS

The following set of tables (1~4) and figures (2~5) are obtained as results after simulation of the students' individual differences. The four figures and four tables represent four different teachers' by one to one correspondence. These obtained results given at tables (1~4) show that average values of means and variances of the four teachers are (35.217,0.0668),(42.61,0.0446),(141.1,24,1.4029)&(55.612,0.5397) respectively. The four lines depicted at the four graphical figures (Fig.2~Fig.5) indicate the Least Mean Square (LMS) values of the obtained output errors. each of the four graphs (fig.2~fig.5) illustrate any of the four teachers' response. That is by representing the relation between the relative error obtained at the output of our NN model and the desired output (correct answer).This relation is given between the absolute relative percentage error{|(actual-desired / desired)|%} obtained by each of students.These errors simulate results of the interaction between any of the teachers and the students occurs during teaching/learning processes. So, the relative errors obtained are following the inherent brain state of our model. It is clear that the 1st teacher presented at fig. 2 is the best one of the four teachers group. However the 3rd teacher is the worst one of this group.

Considering the two previous works [9],[10] the following two remarks are observed:

1- The obtained results are well analogous to the work of "learning with noisy data" that obtained at [9]. That mean the 1st teacher depicted at fig. 2 is analogous to learning with least noisy data(signal to noise ratio). while the 3rd one is analogous to the learning with the most noisy data .
2- Similarly different level of learning abilities shown at [10] depending upon initial set of weights seem to be analogous to the various interactive response performance of the four teachers.

Finally the tabulated results (table 1~4) support that obtained from graphical figures (2~5) respectively.

Table 1. Mean and variance for the 1st teacher. (-0.5~0.0)

Group number	Mean of relative error	Variance of relative error
1	44.89	0.101
2	37.46	0.037
3	32.27	0.021
4	40.05	0.098
5	33.22	0.026
6	33.20	0.027
7	47.66	0.189
8	14.20	0.071
9	34.00	0.031

Table 2. Mean and variance for the 2nd teacher. (-1.0~0.0)

Group number	Mean of relative error	Variance of relative error
1	40.20	0.061
2	44.79	0.055
3	48.55	0.033
4	42.28	0.043
5	45.82	0.042
6	47.78	0.039
7	37.99	0.031
8	36.99	0.051
9	39.08	0.046

Table 3. Mean and variance for the 3rd teacher. (0.0~0.5)

Group number	Mean of relative error	Variance of relative error
1	190.22	2.271
2	141.79	1.359
3	100.36	0.648
4	176.22	1.947
5	129.91	0.981
6	98.180	0.711
7	190.02	2.382
8	143.47	1.548
9	99.950	0.779

Table 4. Mean and variance for the 4th teacher. (-0.5~0.5)

Group number	Mean of relative error	Variance of relative error
1	78.80	0.720
2	54.02	0.337
3	33.97	0.099
4	71.06	0.600
5	47.48	0.218
6	36.60	0.094
7	78.64	0.708
8	61.37	0.358
9	38.57	0.103

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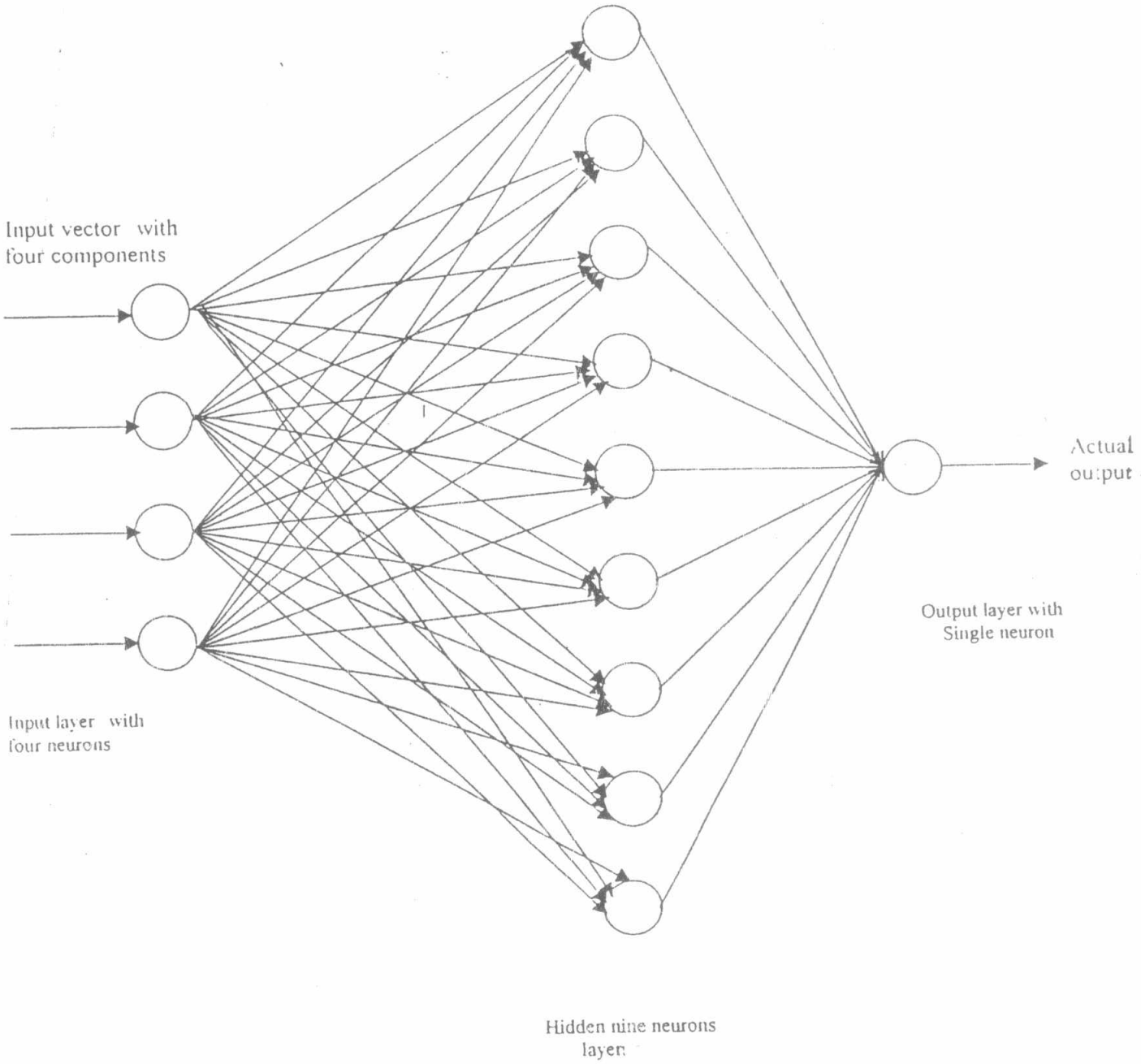

Fig.1 The structure of the model
with four, nine and single neurons
after Kolmogorov [6]

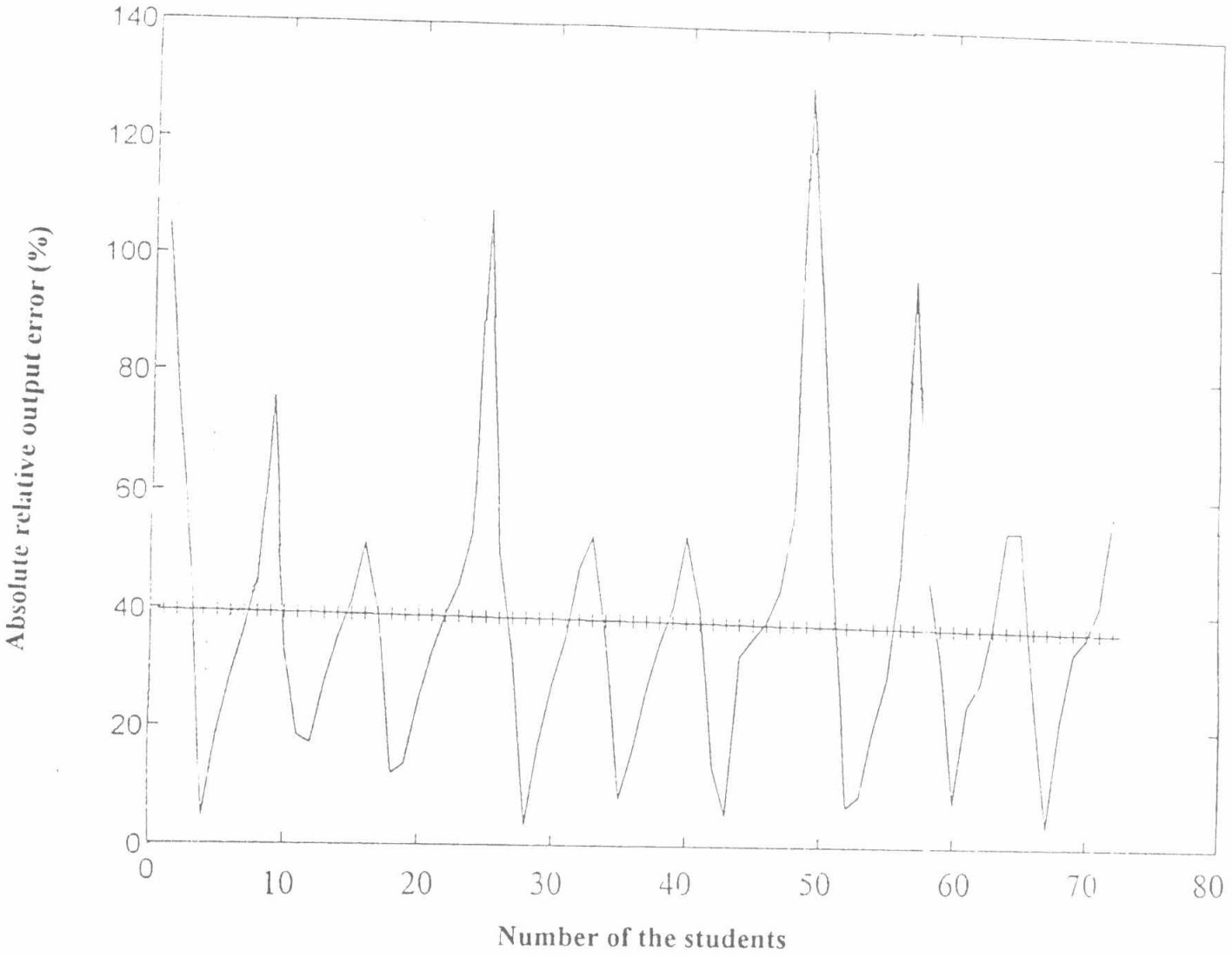

Fig.2 the response performance of the nine students' groups under the supervision of the 1st teacher.

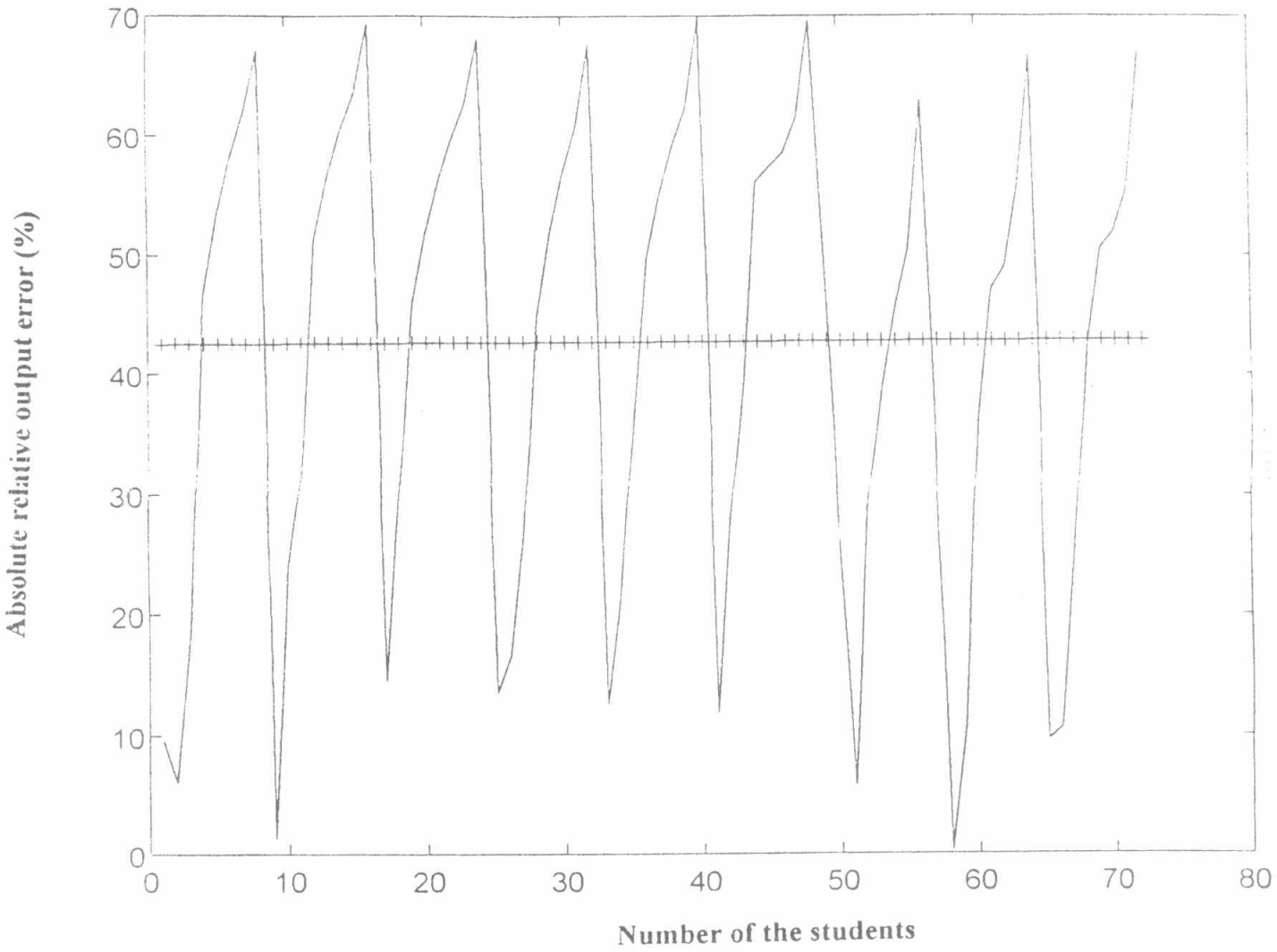

Fig.3 the response performance of the nine students' groups under the supervision of the 2nd teacher.

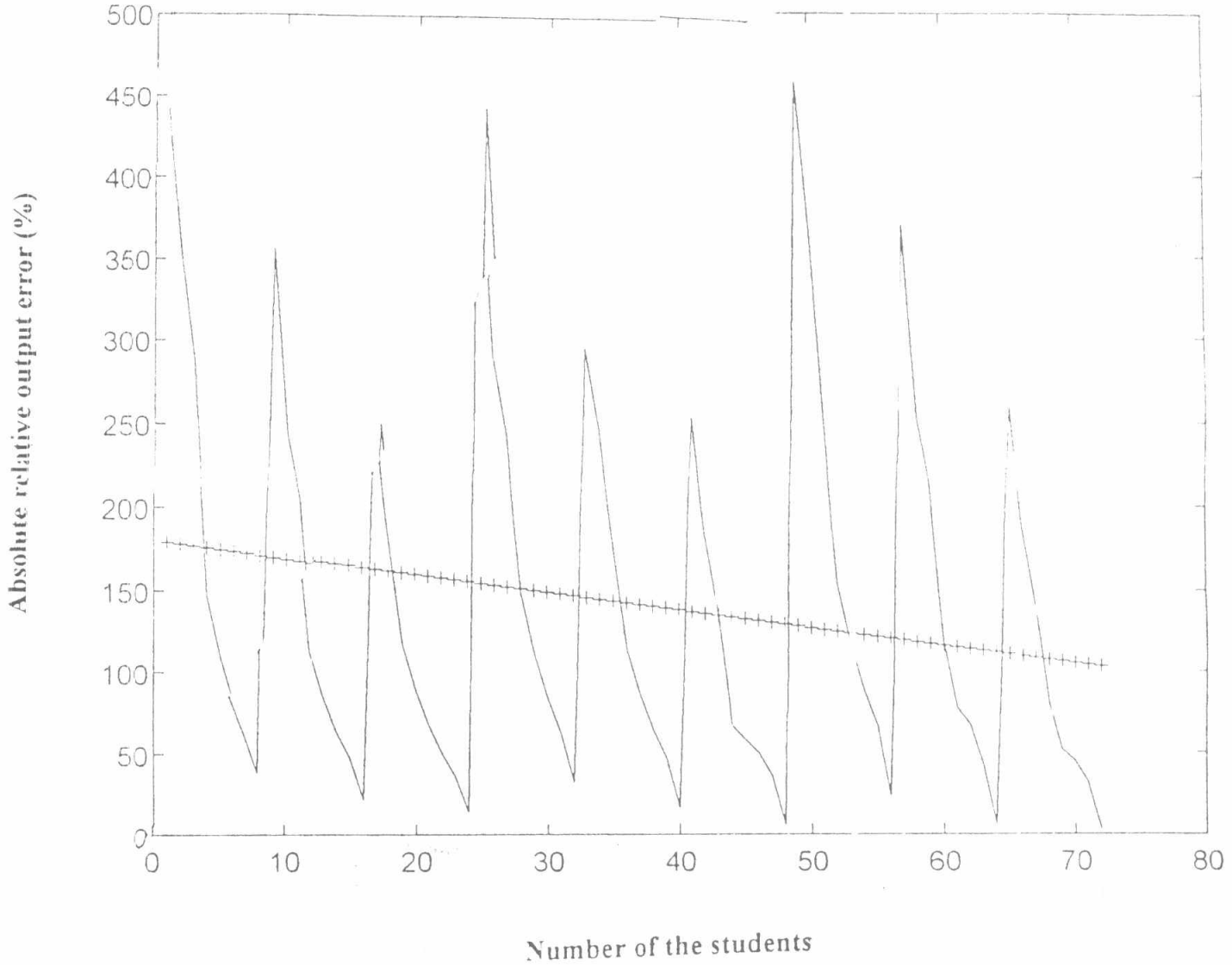

Fig.4 the response performance of the nine students' groups under the supervision of the 3rd teacher.

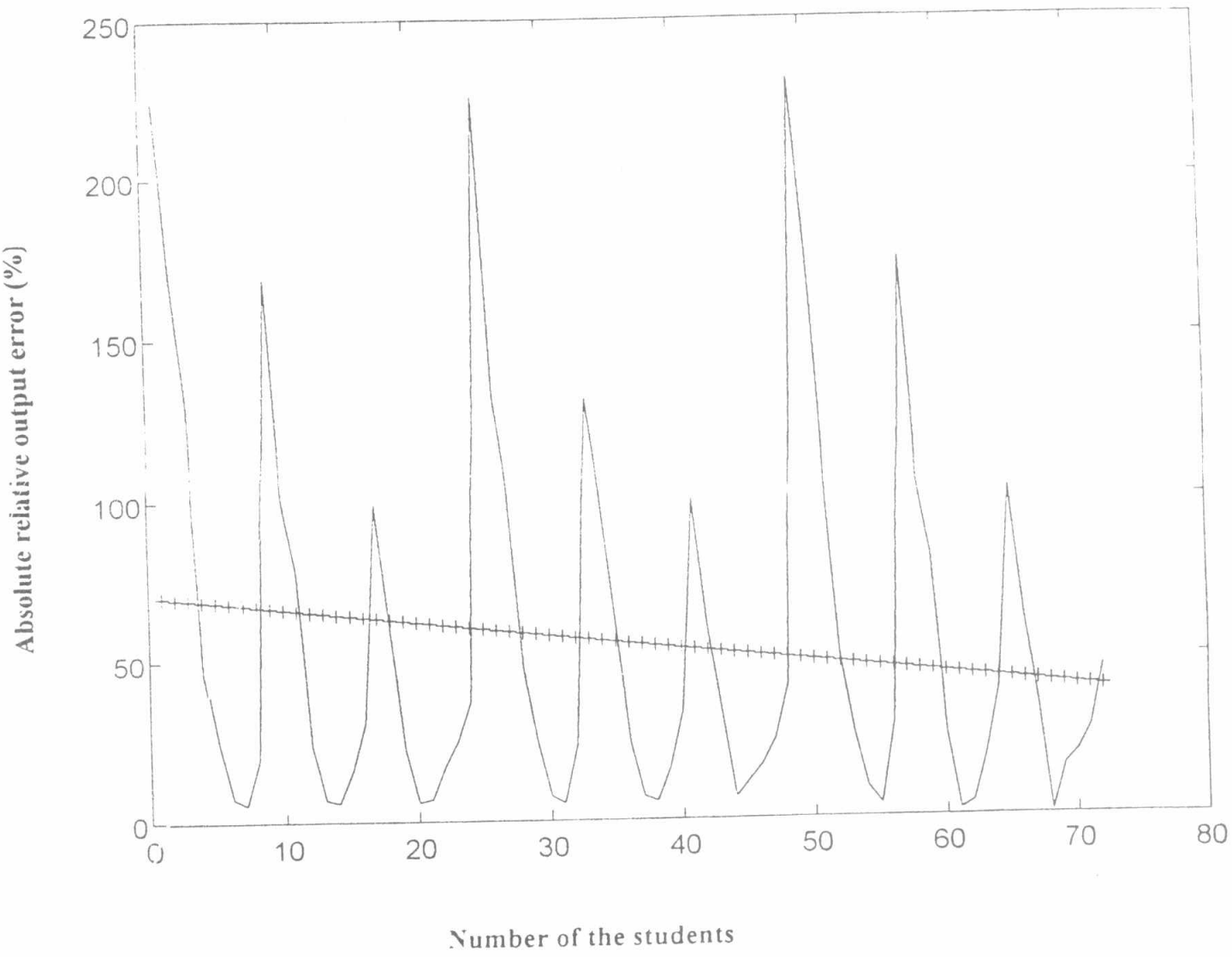

Fig.5 the response performance of the nine students' groups under the supervision of the 4th teacher.

IV- CONCLUSION

The obtained results show how the individual differences of students have great impact on teaching process. Statistical analysis of students' error shows that the best teacher is the first one. However, the most stable learning/teaching performance is obtained by the second teacher. The mean and variance of the obtained errors indicates the performance of each teacher individually. The stability of learning and the average learning level are expressed through the two values of the computed variance and the mean respectively. The suggested ANN model may be modified for further more complex issues dealing with educational technology as comparing different strategies, analysis and evaluation of different computer learning packages, self learning.... etc. The expected modification for the model in the future is to have more resemblance with the biological neural systems [18].

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