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Procedia Social and Behavioral Sciences 1 (2009) 1825–1833

Procedia
Social and Behavioral Sciences

World Conference on Educational Sciences 2009

Comparison of traditional education to computer aided education: simulation of three-phase rotating area in an induction machine

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Received October 25, 2008; revised December 24, 2008; accepted January 5, 2009

Abstract

This study investigates the memorizing level of the students, taught in a traditional and computer aided environment, about teaching of induction motors.
For this purpose, two different class were choose and one was educated in conventional method in which students had no visual tools, the students of the other class were taught by computer aided materials with highly visualized.
In the conventional education, the chosen subject in which changes of induction motors is not visually shown, were memorized by students just only imagination of the induction motors. However, in the computer aided education, the changes of the induction motors are visually simulated on a computer to make the students can follow all the changes of induction motors. The results of the both educational method were measured by applying evaluation tests. In addition to evaluation tests, some periodical tests have been performed each month on the students to understand how fast students forget the learned subject. The reliability of the obtained results was checked by SPSS statistical method.
The experimental results showed that the students who were studied the subject visually by computer aided simulations can memorize the learned knowledge longer than the one who learned by conventional method.

Keywords: Rotatin area; induction machine simulation; three-phazs rotating.

1. Introduction

The technical education in the world has gained new momentum after developments in the computer industry. Only few equipment were used in traditional education if compared to interactive computer aided educational systems. The traditional way of education was book oriented. Not many equipment were used to help students understand better in the classroom, until computers entered the classroom. Computer aided education tools were made the lessons in the classroom more interactive and visual. Animations and simulations were also made possible by the help of computers.
From the beginning of 80'ies, many researchers in the air gap of education have been reporting about computer aided education. Bengu et al [1] employed Total Quality Approach and Critical Thinking Concept to manufacturing education. They proposed to use multi media courseware including on-line lectures, audiovisual tools, and

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1877-0428
doi:10.1016/j.sbspro.2009.01.323

interactive computers software. They also emphasized the effectiveness of the computer aided education. The importance of the computer aided education can also be seen on the reference [1][2][3][4][5]. The details of the computer aided education also depend on the specific subject for which the teaching materials are developed. The workshop education in the technical education faculties has some distinguished points if they are compared with the non-technical education. Technical educations subjects need to be more visualized and should include simulations, animations and interactive learning. Carrying out technical education with the more visualized materials will help the students to keep the knowledge longer in their memory. This is the most important topic in the education: To make students remember the topics of the lessons longer. The old saying by famous Chinese Philosopher Confucius: "I forget what I hear, I remember what I see and I learn what I do" shows the importance of the practice in the field of vocational training.

For better learning and longer remembering, a conventional teaching subject is converted into computer aided teaching. To do this, the content of the lesson has been modified and some simulation software has been developed. In conventional way, only a technical drawing was used to explain rotating air gap between rotor and stator of the induction motor. The rotation of the air gap was not illustrated in the drawing, thus the students had difficulty to imagine the rotation of the air gap. But in the computer aided simulation, the topic was more visualized by simulation and the students could follow all the rotation of the air gap step by step. This could help the students memorize better and longer the rotation of the filed. This same subject was taught to the students of two different classes: 1. in conventional way, 2. computer aided way. Later, the learning levels of the same classes were evaluated by six tests, one each month. As a result of these tests, it was possible to evaluate how the students of the classes remember rotating air gap of the induction motor. The evaluation process indicated that the students of the class in which the subject was taught by computer aided simulation could get higher grades than the one which was taught conventional way [6-9].

2. Teaching Environments

To compare traditional teaching to the computer aided teaching with respect to the longer remembering, two teaching environments were created. These are: 1. Traditional and 2. Computer aided education.

2.1 Traditional education

Presentation of course in traditional teaching

It was assumed that a, b, c phase bobbins were placed on 36-groove stator with $2\pi/3$ phase difference as shown in Figure 2.1.

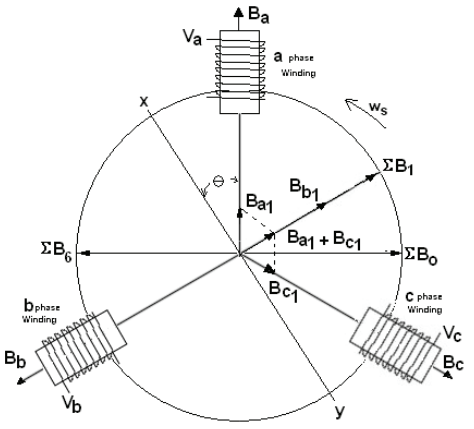

Fig. 2.1 Appearance of phase bobbins with $2\pi/3$ phase shift placed

When the bobbins in Fig. 2.1 are fed with three-phase sinusoidal voltage as shown in Figure 2.2, each bobbin creates alternative areas on its own axis. These areas oscillate by changing their directions on a, b, c axes. The total area of

three bobbins creates an area that rotates with a variable synchronous speed on the direction of constant space between rotor and stator.

Fig. 2.2 shows the three phase current change with time. This current was applied to the system indicated in Fig. 2.1. The amplitudes of such currents are also given in Table 2.1

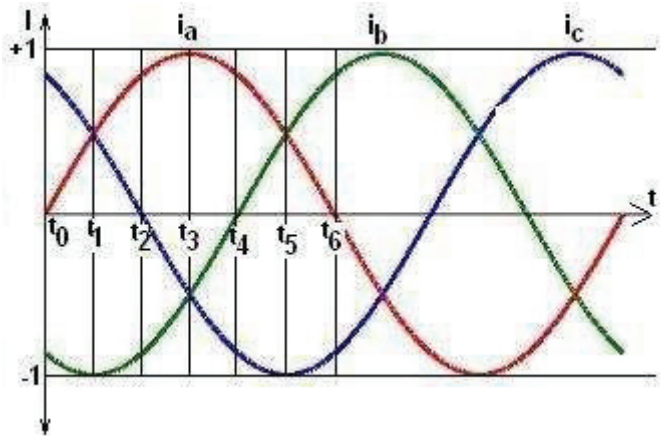

Fig. 2.2 sinusoidal voltage wave type with three-phase and 2π/3 phase shift

Table 2.1 Amplitudes of currents

t	ia	ib	Ic	θ
T0	0	-√3/2	√3/2	0
T1	1/2	-1	1/2	π/6
T2	√3/2	-√3/2	0	π/3
T3	1	-1/2	-1/2	π/2
T4	√3/2	0	-√3/2	2π/3
T5	1/2	1/2	-1	5π/6
T6	0	√3/2	-√3/2	π

The magnetic filed created between rotor and stator is defined by the equation given in [1], If the wave shapes given in Fig. 2.2 is applied to the bobbins given in Fig. 2.1.

$$B_{x,y}(\theta,t) = \sum_{i=a,b,c} B_{i,x}(\theta,t) = B_{a,x}(\theta,t) + B_{b,x}(\theta,t) + B_{c,x}(\theta,t) \quad (1)$$

If the projections of magnetic inductions on x-y vector are:

$$B_{a,x}(t,\theta) = B_a(t)Cos(\theta)$$
$$B_{b,x}(t,\theta) = B_b(t)Cos\left(\theta - \frac{2\pi}{3}\right)$$
$$B_{c,x}(t,\theta) = B_c(t)Cos\left(\theta + \frac{2\pi}{3}\right) \quad (2)$$

The variations of the areas with time created by a, b and c phases on the phase axes are:

$B_a(t), B_b(t)$ And $B_c(t)$

The currents and related areas (ignoring iron loses) can be shown as:

$$i_a(t) = I_m Cos(w_o t)$$
$$i_b(t) = I_m Cos\left(w_o t - \frac{2\pi}{3}\right)$$
$$i_c(t) = I_m Cos\left(w_o t + \frac{2\pi}{3}\right) \quad (3)$$
$$B_a(t) = B_m Cos(w_o t)$$
$$B_b(t) = B_m Cos\left(w_o t - \frac{2\pi}{3}\right)$$
$$B_c(t) = B_m Cos\left(w_o t + \frac{2\pi}{3}\right)$$

Introducing Eq. (3) into Eq. (2) and doing necessary trigonometric changes then putting it into Eq. (1), one can obtain the equation given below;

$$B_{x,y}(\theta,t) = \frac{3}{2}B_m\left[Cos(\theta - w_o t)\right] + \frac{1}{2}B_m\left[Cos(\theta + w_o t - \frac{2\pi}{3}) + Cos(\theta + w_o t) + Cos(\theta + w_o t + \frac{2\pi}{3})\right] \quad (4)$$

As the second term of this equation is zero, the total magnetic area of three-phase bobbin through x-y is obtained by;

$$B_{x,y}(\theta,t) = \sum_{i=a,b,c} B_{i,x}(\theta,t) = \frac{3}{2}B_m Cos\,(\theta - w_o t) \quad (5)$$

This expression is a function with two variables. The variables are θ and t. At a certain point of the air gap is θ = constant and the total magnetic air gap changes sinusoidal according to Equation (5). $B_{x-y}(\theta,t)$ is called the total three- phase air gap magnitude and it is constant ($3/2\,B_m$). The rotating direction of the air gap or wave is clock wise. If the angle is chosen as a reference axis then the turning air gap can be shown as phasor and can be calculated from:

$$B_{(\theta,t)} = \frac{3}{2}B_m e^{-jw_o t} \quad (6)$$

As a result, an alternative rotating air gap with constant vector and variable direction is obtained [10-11].

2.2 Computer aided education

Software has been prepared for the simulation of the subject. The air gap between rotor and stator is visualized in a computer environment. Before the simulation run, the pole number of the induction motors is selected as shown in Fig. 3.1. Then the "draw" button is pushed to obtain the drawing given in Fig. 3.2.

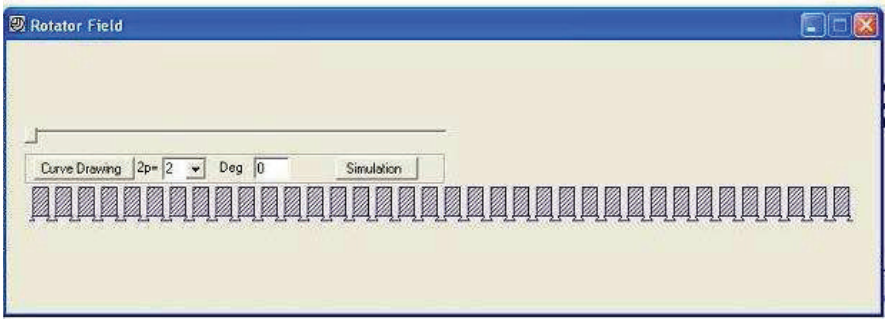

Fig. 3.1 Simulation display

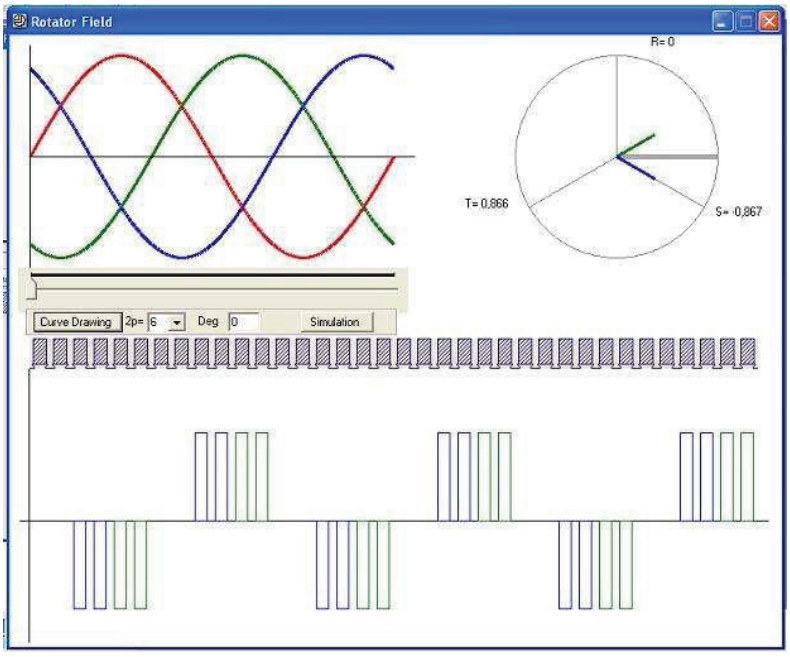

Fig. 3.2 Wave shape simulation of air space in 0°

When the simulation is started according to the selected pole number, in every change of each alternative current, which is separated to 360o parts, the changing of magnetic area under poles and the amplitude of the related vector is simulated numerically. For example, for 132o, it is given in figure 3.3.

The simulation -aided education both gives opportunity to the students to trial the real events and increases the concern of students on the subject. Besides, it ensures active learning opportunity and it is affective for slow learners. It develops the abilities of students such as comprehension, judging, decision -making and analysis.

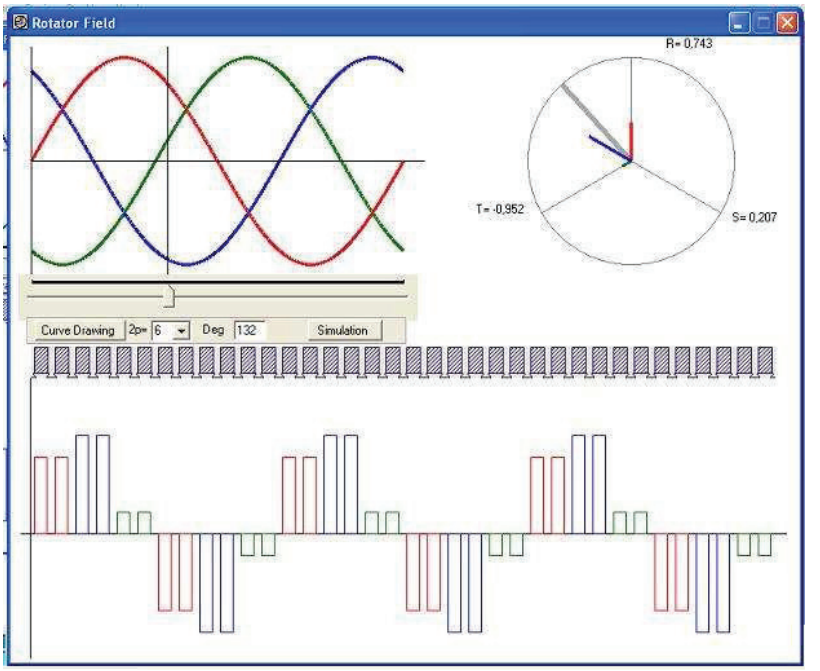

Fig.3.3 Wave shape simulation of air space in 132°

3. Evaluation of Learning and Results

3.1 Method

To compare the results of traditional education to the computer-aided education, the occurrence of three-phase revolving air gap in induction motors is taught to the students of Marmara University Technical Education Faculty, Department of Electricity, Two different classes, one for traditional and the other for computer-aided education were selected, and the length of lessons were four-hours.
A pre-test were applied to the selected students to understand their knowledge about the subject. And then a final test were applied the same groups after four-hour teaching the subject to understand what they have gained during lesson. Another examination, which was done once a month during six months period, was done to the same selected classes to evaluate their recalling levels [2].

3.2 Test results

As a result of pre-test, final and evaluation tests, the average points of two classes, 40 students each, is given table 1. Class 1 is given traditional education and Class 2 the computer-aided education.

Table 1 Average test points of classes

	Pre* - Test	Final ** Test	Recalling*** Test - 1	Recalling Test - 2	Recalling Test - 3	Recalling Test - 4	Recalling Test - 5	Recalling Test - 6
Class 1	11,3	89,925	70,9	62,95	50,2	45,075	33,45	30,6
Class 2	10,85	91,6	75,425	68,225	59,7	56,2	52,35	50,375

* Applied before education
**Applied after traditional and computer added education
***Applied to understand level of knowledge loss once a month during six months period

When the pre-test points of students are evaluated, it is understood that the students do not have sufficient information on the subject. But the points they have got shows that they have only some basic knowledge which is coming from their high school lessons.

After the students completed their four-hour education, they were given a final test to evaluate how well they have learned the subject. The test results revealed that their knowledge on the subject is almost in maximum as seen in Table 1. All the tests are evaluated out of full point 100. Test – 1, Test – 2, Test – 3, Test – 4, Test – 5, Test – 6 are the tests made to understand the recalling levels of the students during six months period, one test in each month. The recalling tests were revealed that there is knowledge loss depending on time. To determine whether there is difference between the point averages under the equivalency of mass variances calculated for two classes, the t values calculated with SPSS (Statistical Packages of Social Sciences) are given in Table 2.

Table 2 t values between the differences of point averages of classes

	Pre -Test	Last Test	Recalling Test – 1	Test – 2	Recalling Test - 3	Test - 4	Recalling Test - 5	Test - 6
t12	0,614689	1,1059095	-1,348133	-1,490994	2,622699	-4,145471	-6,47527	-9,946

α=0.05 significance level's degrees of freedom is 78 (n1 + n2-2 = 40 + 40 – 2 = 78). The table value for 78 freedom degree of double sided t is t ≅ ± 2.00. The hypothesis of equivalency of point averages of recalling level determining tests made within months, pre-test and final test is an acceptable hypothesis. As it can be seen in Table 2, the results of pre-test and final test are under t=2.00.

When the point averages of tests made for determining the recalling level are compared up to third test, it is seen that these three tests' mass averages, which are within with 95 % possibility, are not very much different. However, the assumption of equivalency of mass variance is not equal and correct for the tests 3, 4, 5 and 6. This means that points differ from each other in the great rate. The graphic in Figure 4 is obtained from the data in Table 1.

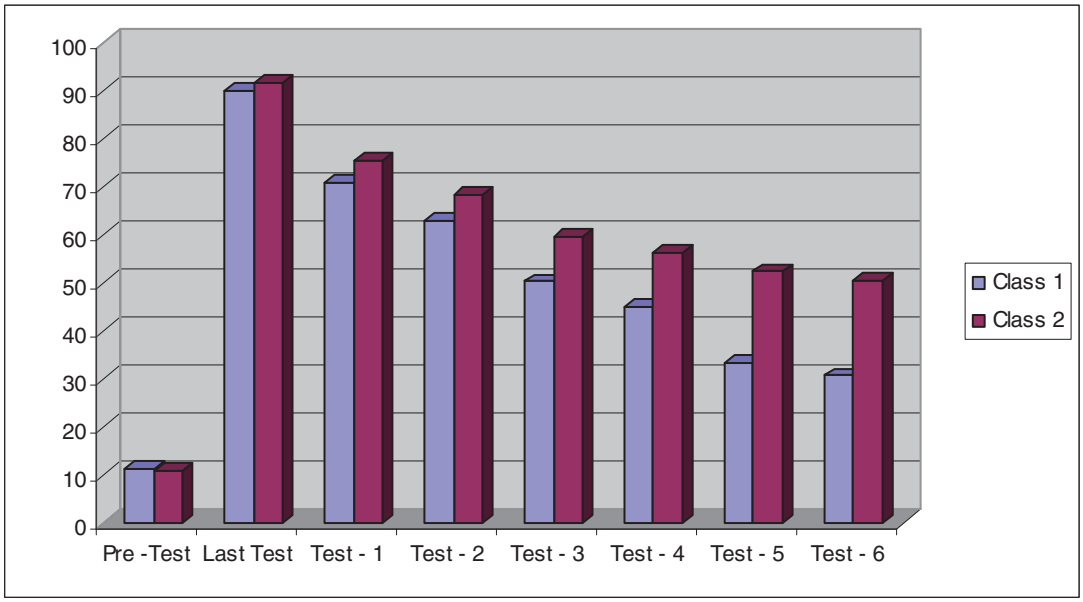

Figure 4 Results of average test points of classes

Figure 4 shows that the tests made for purpose of determining the recalling levels of students. This figure reveals that the recalling levels of the two groups are almost close to each other in the first 3 months after teaching. But the recalling differences between these two groups are increased after three months of teaching. And as the time extends the difference in recalling between two groups becomes bigger.

Table 4. The percentage ratio of recalling tests/final test after 6-month passed

	1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month
Class 1	21,1565193	29,99722	44,175702	49,8748957	62,802335	65,971643
Class 2	16,1245482	24,13122	33,6113428	37,5034751	41,784821	43,9810954

As it can be seen in Table 4, more knowledge loss in traditional education occurs when the months pass, if compared to computer-aided education. The change of knowledge loss is given in Figure 5 graphically.

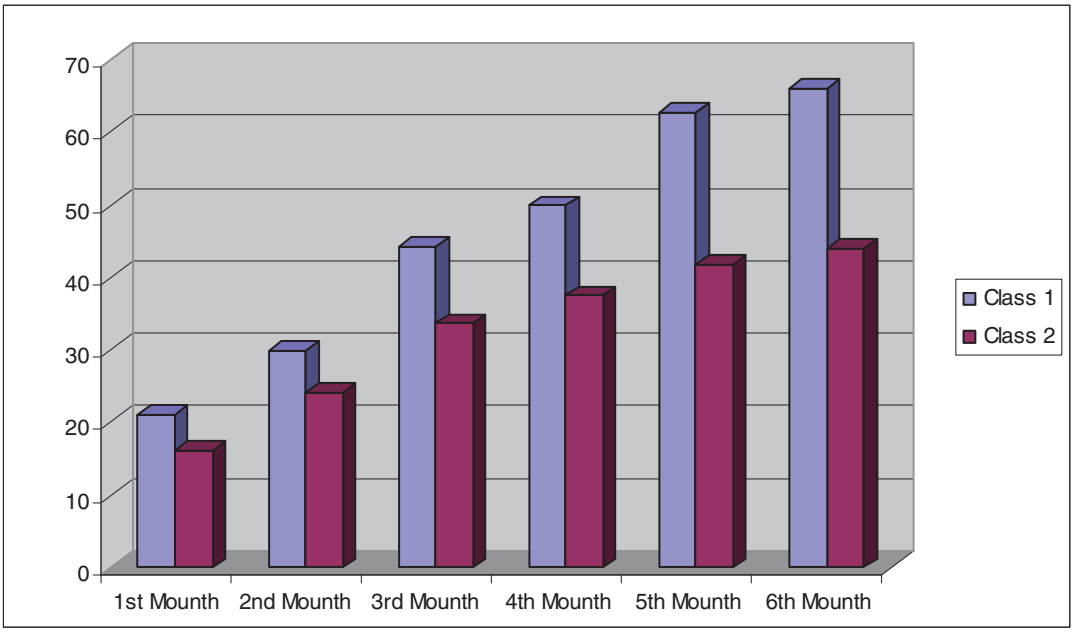

Fig. 5 Comparison of change of knowledge loss

4. Conclusion

Experimental teaching methods using traditional and computer aided techniques were used in this study to understand the affect of the teaching methods on knowledge loss and recalling. To evaluate the results of the examinations t test evaluation method was employed. The following conclusions were obtained from the present study.

1. The students who are taught the subject of induction motors using simulations on the computers have got higher points from the examinations. This confirms that computerized simulations are more effective in teaching if compared to traditional book oriented teaching.
2. The knowledge losses occur as a result of the both teaching methods. But the knowledge loss is faster in the class, which was taught by using traditional teaching method.
3. t test evaluation method confirmed that the examination results are reliable.
4. From this study, it is possible to say that visualized education, with the help of computer are easier to understand the subject and causes longer memorization.

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