DISTANCE EDUCATION: EDUCATIONAL TRAJECTORY CONTROL

Andrey Isaev, Alla Kravets, Ludmila Isaeva and Sergey Fomenkov
Volgograd State Technical University,
Volgograd, Russia

ABSTRACT

Distance education has become a rather popular form of education recently. The advantages of this form are obvious and well-known. They include asynchronous learning, individualized learning trajectories and convenient case technologies. However, the distance form of education is not able to form the trainee's hands-on experience, especially concerning the complicated technological equipment. Besides, it cannot form one's personal communication skills of working in the team. That's why many distance teaching programs include synchronous teaching elements. The difference in the students' achievements creates a lot of problems in the organization of educational groups. The principle of dynamic study group forming for a short-term synchronous teaching is proposed by the author as a way of solving such problems.

KEYWORDS

Distance learning, individualized educational trajectory, educational process control.

1. INTRODUCTION

The development of modern e-learning platforms (Cecilia Rossignoli et al, 2013; Margot McNeill et al, 2010) and electronic search and processing marked the highest priority of distance learning. The problem of new effective pedagogical technologies development has been paid a lot of attention to recently. Researchers (Dr. Ajay Kumar Attri, 2012; Said Hadjerrouit, 2013) propose methods, strategies and technologies of the distance learning. Further research into course development techniques will help educational institutions understand which methods work best in the distance teaching.

2. DISTANCE EDUCATION: EDUCATIONAL TRAJECTORY INDIVIDUALIZATION

Extra-mural education is the closest in its form to distance education in the Russian higher education system. The peculiarity of this education form is the integration of asynchronous teaching and synchronous final control. The curriculum is formed in the following way (Fig. 1): the first one or two weeks are dedicated to the students' starting acquaintance with the curriculum contents, the study, as a rule, being organized in the mode of synchronous teaching. The future student's training is realized in asynchronous teaching form and presupposes the student's individual work with the published sources, recommended Internet resources and the information of the case provided. At the end of the course the student is to fulfill practical tasks and laboratory practice in synchronous teaching mode. The course is completed with final examination (Titova O.V. and Kravets A.G., 2013).

Such organization of educational process is realized in Eurasian Open Institute, London School of Business and Finance (LSBF), National University (USA), National University – UNED (Spain) and other systems of open education. Nevertheless, it should be taken into consideration that the efficiency of students' achievements in the distance teaching mode depends on their self-organizational ability and effective system of inner motivation to a great extent [1].

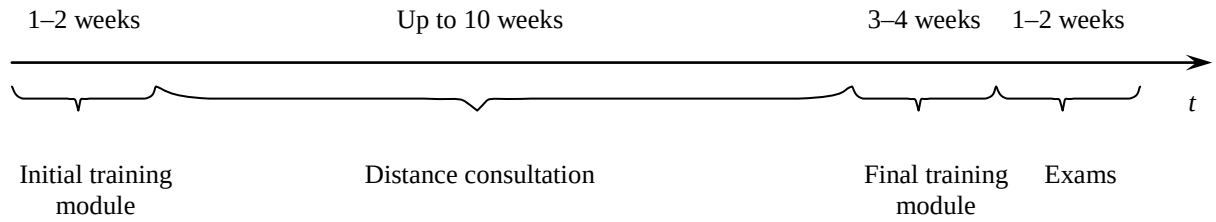

Figure 1. Time portrait (initial) of the distance education process structure

According to the inertial subject concept, proposed by us, the process of mastering the curriculum by the student is nonlinear (Fig. 2) and consists of the parts represented one after another [2, 3]:

AB – student's interest development (mastering the means used in the particular field of knowledge);

BC – information component widening (the set of tasks solved with the mastered means);

CD – elaborating the techniques and methods of specialized information processing;

DE – optimizing the ways of information storage (knowledge transformation onto personal level);

EF – new specialized means development.

On the diagram (Fig. 2) the value of *Z* characterizes the student's real achievements level, quantitatively determined as

$$Z = \sum_{i=1}^{n} k_i R_i ,$$

where k_i is the vector of the weight coefficients determining the significance of this or that competence in the professional portrait of the graduate, R_i is the rating grades vector determining the level of mastering the competence.

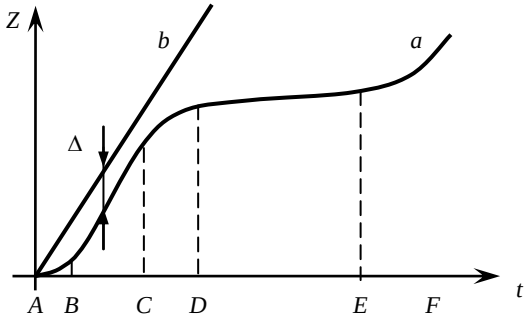

Figure 2. Individualized educational trajectory

In a number of works we substantiate that the necessary condition of forming the student's stable motivation is creating the range of acceptable deviations Δ_Z of one's real educational trajectory (Fig. 2 line *a*) from the defined one (Fig. 2 curve *b*). Δ_Z range narrowing to the level lower than acceptable one results in student's overestimated self-appraisal forming and, therefore, lowering the level of further studies motivation. Vice versa, Δ_Z range widening forms the feeling of apathy because the student understands his or her inability to achieve the result.

On the basis of these developments the distance education management system was created by the author, its pilot project being realized in Svetly Yar branch of Moscow State University of Technologies and Management named after K.G. Razumovsky. Its main characteristic feature is distributing the time resource for synchronous teaching realization inside the interval of students' distance consulting. As the educational process is inertial, this distribution is nonlinear: the greatest intensity of synchronous education periods is displaced to the beginning of teaching. Such educational process structure allows the students to master the means used in the educational course in the most effective way. These means include terminology (concepts and definitions), methods and algorithms of data processing and work with specialized IT contents.

The following algorithm serves as the basis of this system:

1. Developing the individualized task according to the curriculum. The task consists of a number of smaller tasks to be solved by the student one after another, the results being the source data for the final task according to the curriculum.

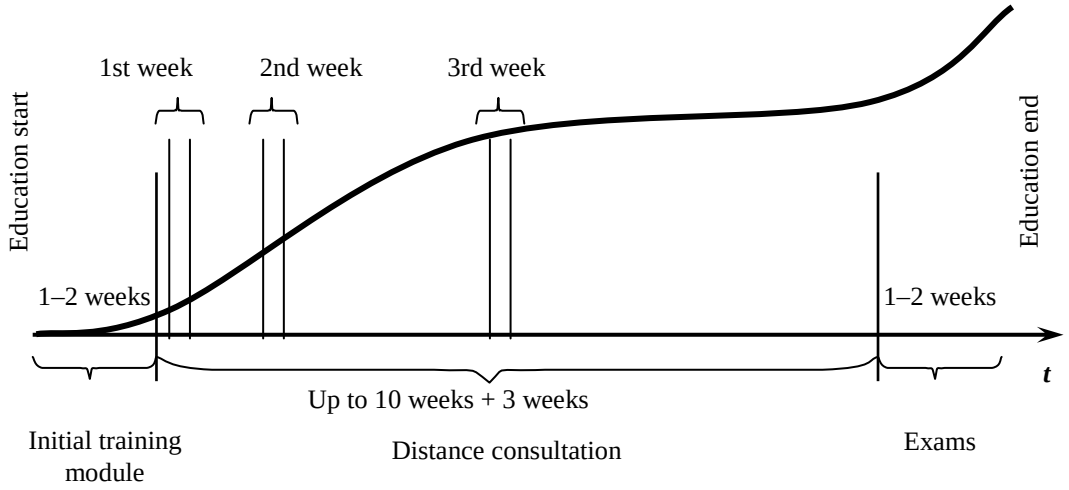

Figure 3. Time portrait of the distance education process structure proposed

2. The whole time interval that the student has for individual work is divided into small time parts with control reports. Such reports are carried out either in the off-line/on-line mode of testing or on-line interview.

3. According to testing results it is decided if additional consultations are necessary, the subject, volume and form being taken into consideration.

4. Study groups are formed for short-term synchronous teaching. The aim of this teaching is developing students' professional competences necessary when operating real equipment.

5. The organization of students' final control.

It should be stressed that the study groups' structure was not strictly defined and the groups were formed according to the intermediate control of all the students in parallel groups.

3. TESTING THE PROPOSED EDUCATIONAL PROCESS STRUCTURE

To check the efficiency of the proposed teaching process two groups were formed: the students' experimental group *A* (36 people) and control group *B* (38 people). The groups consisted of the extra-mural students in Svetly Yar branch of Moscow State University of Technologies and Management named after K.G. Razumovsky.

The analysis of group participants' competence level is represented in two stages, fixing and transformational ones. On the first fixing stage the comparability analysis of two students' groups (*A* and *B*) was carried out as for the difference of their starting level achievements. According to the results of the starting testing, students were divided into three subgroups characterized by low, intermediate and advanced levels of students' starting achievements.

Table 1. Groups qualitative analysis according to academic achievements (according to the starting control results)

No.	Number	Formula	Assessment criterion		
			Low level	Intermediate level	Advanced level
For group A (experimental)					
1	Students total, people	N	36		
2	Absolute number, people	N_A	20	11	5
3	Relative number, %	$\delta = \frac{N_A}{N} \cdot 100\%$	55.6	30.6	13.9
For group B (control)					
1	Students total, people	N	38		
2	Absolute number, people	N_B	25	10	3
3	Relative number, %	$\delta = \frac{N_B}{N} \cdot 100\%$	65.8	26.3	7.9

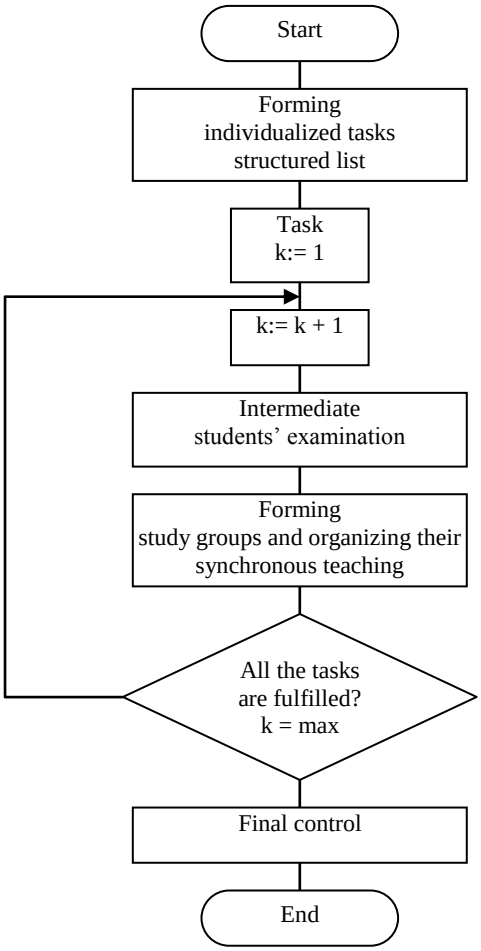

Figure 4. Teaching process algorithm in distance education

Let us establish the characteristics matching or difference in the experimental and control groups. For this purpose let us propose statistical hypotheses:

- the hypothesis of differences absence (a null hypothesis);
- the hypothesis of differences significance (an alternative hypothesis).

Statistical tests are used to decide which hypothesis should be accepted. In our research Welch's *t*-test is used for testing the hypothesis concerning the characteristics matching in two groups [4]. The value, which is called the observed test value, is calculated on the basis of observation results. This value is compared with the known reference value specified in the tables, which is called the critical test value. In pedagogical researches the value of 0.05 is usually the limit that means the possibility of an acceptable mistake being less than 5%.

If the observed test value obtained proves to be less than the critical one or equal to it, the null hypothesis is accepted: the control and experimental groups' characteristics match. Alternatively, if the observed test value proves to be strictly higher than the critical one, the null hypothesis is declined and the alternative hypothesis is accepted: experimental and control groups' characteristics are considered different, the difference validity being 0.95 or 95%.

The observed value of Welch's *t*-test is calculated according to the following formula $T = \frac{\sqrt{M \cdot N}\ \left|\bar{x} - \bar{y}\right|}{\sqrt{M \cdot D_x + N \cdot D_y}}$, where *N*, *M* – sample sizes of *x* and *y*, $\bar{x}, \bar{y}$ – sample means, D_x, D_y – sample variances.

To calculate the main characteristics the following formulae were used:

$\bar{x}(\bar{y}) = \frac{1}{N}(k_1 x_1 + k_2 x_2 + \ldots + k_N x_N)$, where k_i – weight significance coefficients,

$D_x(D_y) = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2$.

Students' experimental group *A*

Sample mean: $\bar{x} = \frac{1}{36}(20 \cdot 1 + 11 \cdot 2 + 5 \cdot 3) = 1.58 \cdot$

Sample variance: $D_x = \frac{1}{36-1}\left[20(1-1.58)^2 + 11(2-1.58)^2 + 5(3-1.58)^2\right] = 0.54 \cdot$

Students' control group *B*

Sample mean: $\bar{y} = \frac{1}{38}(25 \cdot 1 + 10 \cdot 2 + 3 \cdot 3) = 1.42 \cdot$

Sample variance: $D_y = \frac{1}{38-1}\left[25(1-1.58)^2 + 10(2-1.58)^2 + 3(3-1.58)^2\right] = 0.41.$

The observed value of Welch's *t*-test: $T = \frac{\sqrt{36 \cdot 38}\left|1.58 - 1.42\right|}{\sqrt{36 \cdot 0.54 + 38 \cdot 0.41}} = 1.02 \cdot$

Hence $T = 1.02 \ < 1.96$. Therefore, the hypothesis of control and experimental groups' characteristics matching before the beginning of the experiment is accepted on the significance level of 95%.

4. THE EXPERIMENT RESULTS EVALUATION

The educational process for control group *B* did not undergo any changes either in the teaching course structure or in the principle of study groups' forming.

For group *A* the time resource at the end of the educational course for synchronous teaching realization was divided into smaller time intervals that were evenly distributed in the time range for individual work. Subgroups of group *A* students were formed for carrying out short-term teaching in each such interval. The main choice criterion was the student's achievements fixed level that was evaluated on the basis of current control in the form of on-line testing.

The following results (Table 2) were obtained at the final examination of both groups' students.

Table 2. Groups qualitative analysis according to academic achievements (according to the final control results)

No.	Number	Formula	Assessment criterion		
			Low level	Intermediate level	Advanced level
For group A (experimental)					
1	Students total, people	N	36		
2	Absolute number, people	N_A	9	21	6
3	Relative number, %	$\delta = \frac{N_A}{N} \cdot 100\%$	25.0	58.3	16.7
For group B (control)					
1	Students total, people	N	38		
2	Absolute number, people	N_B	21	14	3
3	Relative number, %	$\delta = \frac{N_B}{N} \cdot 100\%$	55.3	36.8	7.9

To evaluate the comparability of the two study groups, control and experimental ones, the above mentioned method was used. The obtained Welch's *t*-test value was T = 2.59.

As $T = 2.59 > 1.96$, the hypothesis concerning the difference in characteristics of control and experimental groups after the teaching process is true on the significance level of 95%.

The qualitative structure of experimental group *A* and control group *B* according to the starting and final testing is represented graphically in Figures 5 and 6.

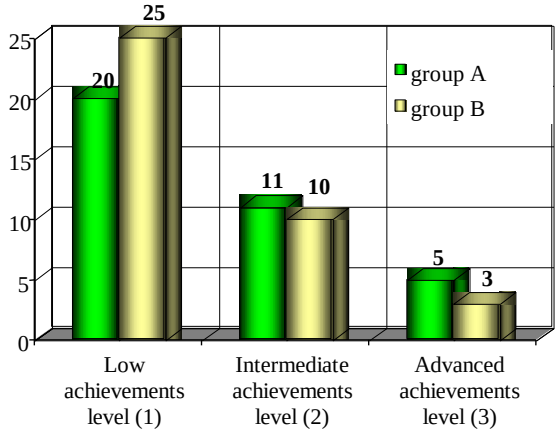

Figure 5. Comparative diagram of the starting testing results for experimental (*A*) and control (*B*) groups

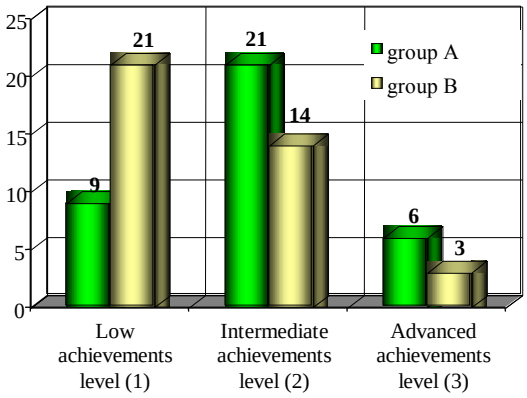

Figure 6. Comparative diagram of the final testing results for experimental (*A*) and control (*B*) groups

According to the academic achievements, the qualitative structure of experimental group (*A*) has changed: the number of students with intermediate and advanced achievements level (Table 3) has increased. Welch's *t*-test value was 3.5 when academic achievements level in group *A* before and after teaching were compared. It proves substantial differences in the academic achievements levels in this group in the beginning and at the end of teaching.

Table 3. Experimental group A qualitative structure analysis according to the academic achievements (in the starting and final testing)

No.	Number	Formula	Assessment criterion		
			Low level	Intermediate level	Advanced level
	Starting testing				
1	Absolute number (students total: 36), people	N_A	20	11	5
2	Relative number, %	$\delta = \frac{N_A}{N} \cdot 100\%$	55.6	30.6	13.9
	Final testing				
1	Absolute number, people	N_A	9	21	6
2	Relative number, %	$\delta = \frac{N_A}{N} \cdot 100\%$	25.0	58.3	16.7
		Relative number change:	**30.6 ↓**	**27.7 ↑**	**2.8 ↑**

Some changes of group qualitative structure according to the academic achievements level (Table 4) have also taken place in control group (*B*). Nevertheless, Welch's *t*-test value compared before and after teaching in this group was 0.7 (<1.96). It proves the fact of the group qualitative structure to be unchanged up to 95%.

Table 4. Control group B qualitative structure analysis according to the academic achievements (in the starting and final testing)

No.	Number	Formula	Assessment criterion		
			Low level	Intermediate level	Advanced level
	Starting testing				
1	Absolute number (students total: 38), people	N_B	25	10	3
2	Relative number, %	$\delta = \frac{N_B}{N} \cdot 100\%$	65.8	26.3	7.9
	Final testing				
1	Absolute number, people	N_B	21	14	3
2	Relative number, %	$\delta = \frac{N_B}{N} \cdot 100\%$	55.3	36.8	7.9
		Relative number change:	**10.5 ↓**	**10.5 ↑**	**0**

5. CONCLUSIONS

In the pilot project of managing the extra-mural students' educational process in Svetly Yar branch of Moscow State University of Technologies and Management named after K.G. Razumovsky the following work was carried out:

– starting testing technology to determine real level of students' achievements was developed and introduced;

– intermediate control technology for the current level of students' achievements was developed and introduced;

– the main principles of reorganizing the teaching course to actualize the motivation system taking into consideration the students' individual characteristics were developed;

– the main principles of the teaching course to allow integrating the advantages of synchronous education into the extra-mural form according to the students' individual characteristics were developed.

The following results were obtained:

– objective assessment:

– changing the qualitative structure of the study group according to the academic achievements (Table 3): the number of students with low academic achievements level has decreased;

– the level of general achievements in experimental group *A* is higher than in control group *B*;

– subjective assessment:

– students' interest to their learning has increased;

– students' perception level of the curriculum has increased;

– positive basis for educational process perception by the students has been formed.

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