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"LIFELONG LEARNING" IS A NEW PARADIGM OF PERSONNEL TRAINING IN ENTERPRISES

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У контексті управління навчанням виконаний аналіз особливостей та узагальнення структури взаємодії основних сутностей процесу, як власників знань. Показано, що система безперервного навчання є найважливішою складовою ефективної діяльності персоналу компаній. Віднесення основних носіїв знань команди, замовника, систем навчання і глибинних знань до певних дискретних станів, в яких може перебувати система, дозволяють відобразити систему за допомогою ланцюга Маркова

Ключові слова: навчання, парадигма, безперервність, управління, комунікації, ланцюги Маркова, носії знань, трансфер

В контексте управления обучением выполнен анализ особенностей и обобщение структуры взаимодействия основных сущностей процесса, как владельцев знаний. Показано, что система непрерывного обучения является важнейшей составляющей эффективной деятельности персонала компаний. Отнесение основных носителей знаний – команды, заказчика, систем обучения и глубинных знаний к определенным дискретным состояниям, в которых может находиться система, позволяют отобразить систему с помощью цепи Маркова

Ключевые слова: обучение, парадигма, непрерывность, управление, коммуникации, цепи Маркова, носители знаний, трансфер

1. Introduction

The defining paradigm of modern education is the development of a system of continuous, purposeful training of specialists in postgraduate training and completion of special education programs at the choice of organizations and expert's personal desire [1]. The need for "lifelong learning" is justified by rapidly changing economic conditions, technological systems and therefore – the pressing needs of the orientation of the growing amount of new data and knowledge [2]. Throughout the working life, specialists should be able to determine the area of deficiency of their knowledge and competence to focus on searching for the ways to overcome the shortage of skills and meet educational needs under the terms of career growth and personal improvement and development. World practice of such training is based on the modern paradigm of continuous postgraduate education – "lifelong learning" (LLL). The recommendations of the European Commission "Making a European area of lifelong learning a reality" define lifelong learning as "all learning activity, undertaken throughout life, with the aim of improving knowledge, skills and competencies, within a personal, civic, social development, and/or employment-related perspective" [3]. Implementation of the new law of Ukraine "On education" also provides for the creation of conditions for lifelong learning.

Formation of openness of continuing education directs educational institutions to adapt to the requirements of practice by creating a learning environment and increasing skills of working professionals and guest students [4]. Thus, the role of individual learning increases [5]. The students and groups of students with different levels of education and training have different levels of motivation and attitude to education, varied experience. To resolve this contradiction, new departments, centers, programs and special training should be created for high-quality educational services with training. The openness of educational institutions and educational systems is realized through the educational and scientific programs and training different in content and focus.

Development of theoretical foundations of a new paradigm of "lifelong learning" – education throughout the life is an important area of research because the constant training ensures the effective work of the staff of organizations and enterprises.

2. Literature review and the problem statement

Changes in the education paradigm have become manifest in recent times, especially in the difference between understanding and acceptance of different value systems, new learning methods and methods of assessing the success of learning in the teaching practice, not only in the formation of different sets of competencies which are needed by personnel for the success of companies in a turbulent environment [6]. "Lifelong learning" has become over the past few years a popular topic of research and practical developments in the world. Search in Google for keywords "Lifelong learning" has shown millions of web pages (Table 1).

Table 1

The number of Web pages for keywords "Lifelong learning"

Attribute Search in Google for Keywords	Query language	The number of web pages, millions
Lifelong learning	en	18.6
Lifelong learning in the USA	en	1.3
Lifelong learning in Europe	en	1.4
Lebenslanges Lernen in Deutschland	de	0.539
Apprentissage à vie en Français	fr	13.1
Lifelong learning in the UK (England)	en	2.65
Lifelong learning in China	en	0.978
终身学习在中国 (China)	cn	2.88
Lifelong learning in India	en	1.01
भारत में आजीवन सीखने (India)	in	0.132
Lifelong learning in Japan	en	0.894
日本における生涯学習 (Japan)	jp	22.4
Навчання через все життя (Ukraine)	ua	1.5
Навчання впродовж життя (Ukraine)	ua	0.437

Among the Web pages found there are thousands of books, articles and educational materials that highlight different perspectives on the problem of "Lifelong learning". A large half of Internet materials are dedicated to providing services and resources to promote various aspects of lifelong learning. The undisputed leaders in the number of links on the Internet space by the theme of "Lifelong learning" are the countries: Japan (over 23 million), France (13.1 million), China (nearly 4 million) and Britain (2.65 million) (Table 1).

The principles of continuous education in the context of "lifelong learning" are systematizing [7]. Educational institutions and representatives of industry should review the assessments of the role and place of continuing education in the life of every professional and society as a whole. The focus on "encyclopedic" learning content, learning material overload should be shifted. Education should contain practical aspects of science, technology and culture. It shall form the competence of professionals of the future. The current paradigm of education: "Knowledge for life" is transformed with the demands of the time in a new form of education: "Knowledge through life" [7].

The benefits of continuing education are reflected in social practices (social aspect) and the development of personal qualities of students (the aspect of personality). The first aspect is related to the creation of a system of continuous education, the second – with the adoption of new individual knowledge and competencies, which is transformed into professional achievements [8]. This allows to secure the relationship between the responsibility of society and the individual to improve educational technologies and methods [9].

The acute need of companies and organizations in the continuing education of staff is recognized as an actual problem, due to the spread of scientific and technological achievements and professional requirements to the nature of work [10]. The format of lifelong education is understand as a set of learning techniques and the organizational and technical process of learning improvement, which changes the theoretical bases of formation of the educational content and methods of presentation and consolidation of educational elements [11].

But despite the general considerations regarding the effectiveness of continuous education, it should be noted that the theoretical basis of this research area requires further development and justification of providing quantitative ratings. The transition from qualitative assessments of the effectiveness of continuous education to the quantitative assessment can be made by using mathematical models. But now there are no models which would reflect the quantitative performance indicators and would allow to justify the need to move to a new paradigm of training of the company's employees [12]. This research reviewed the typical structure interaction knowledge of management training, which made it possible to use a Markov chain to model these systems.

3. Research goal and objectives

The goal of the study is a justification of continuing education of the staff of organizations with the help of the cognitive model of knowledge interaction in project management to effectively acquire new knowledge and skills.

To achieve this goal, the following tasks were set:

– to analyze existing methods and tools for creating the cognitive model of knowledge interaction;

– to transform the cognitive model of knowledge interaction into a homogeneous Markov chain with discrete states which correspond to the knowledge holders;

– to identify the types of source data in educational projects based on the indicators of uniqueness of projects for customers and performers;

– to define how the system will behave in the event of "connection" with the in-depth knowledge and appeal to the education system to make the necessary transfer of new knowledge to the project.

4. Creating a cognitive model of knowledge interaction

As a simplified model, we consider an approach to the classification of projects based on the project uniqueness evaluation for two major project stakeholders - the customer and the performer (Fig. 1) [13]. Since most innovative projects solve unique challenges, transformation of knowledge from the environment should be carried out for their implementation [14].

Each project, by definition, has the properties of uniqueness, despite the definition of competence, proposed by PMI in PMCDF [15], the project team not in all cases will have a complete set of all necessary competencies for work on a project.

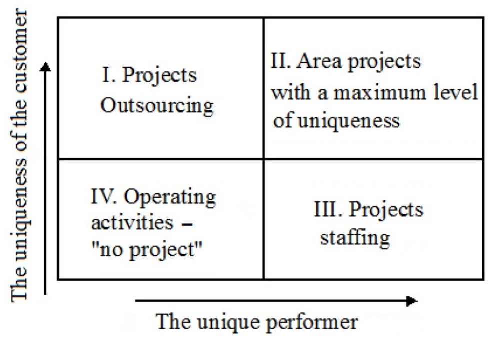

Fig. 1. Classification of projects by the degree of uniqueness

In accordance with the classification (Fig. 1), for the successful implementation of each project, the project team must have different "sets" of competencies and different "amounts" of knowledge [8].

It is obvious that for projects of the II type, where the project is unique both for the customer and for the project team at the beginning of the work, the project team may not have such a range of knowledge that will make it possible to successfully complete the project. Otherwise, it will be another type of project.

If a project is unique to the customer, and project implementers are fully knowledgeable about the features of the project, there is the option of interaction between the customer and the performer on the principle of outsourcing (type I). The customer full works on the project to the executor (the project team). This option of a combination of the project uniqueness for the customer and the project team is connected with the necessity of close interaction between the customer and the performer in the implementation of the project in order to increase the customer knowledge level that will ensure the operation of the project product.

Another version of the interaction between the project team and the customer arises in the case when the customer has full knowledge of the features of the project, and the performer doesn't (type III). In this case, the executor is involved in the project under the supervision and with the participation of the Customer. In this instance, the project team gets novel knowledge and practical experience under the guidance of the customer.

The critical situation occurs when both of the project participants (project team and the customer) do not have the knowledge to carry out the project. The project is unique for both parties concerned (type II). For the customer, this problem can be solved simply – to find another performer who has a full set of knowledge for successful completion of the work. For the project executor, there are two ways out of this situation. The first way is to abandon the project. The second way is to obtain the necessary knowledge for this project. The ways of acquiring knowledge can be different: learning, research, training, professional advancement, learning best practices, internship and others. The main feature of the process of acquiring knowledge is that new models, methods, processes and mechanisms are transmitted to the system from the environment. If the project team can get this new knowledge, they will relocate the project from the critical region to the area in which risk is acceptable. Thus, the project will no longer be unique to the project team and pass from type II to type I.

Classification of projects according to their uniqueness for the executor and the customer (Fig. 1) allows us to formulate the following statement: "In the management of unique projects, at the beginning no project team will have a set of competencies and knowledge which will be sufficient for the successful completion of the project".

Thus, for successful implementation of the project, the project team should be constantly learning and transferring knowledge from the environment (outside) to the system of knowledge (education system) (Fig. 2).

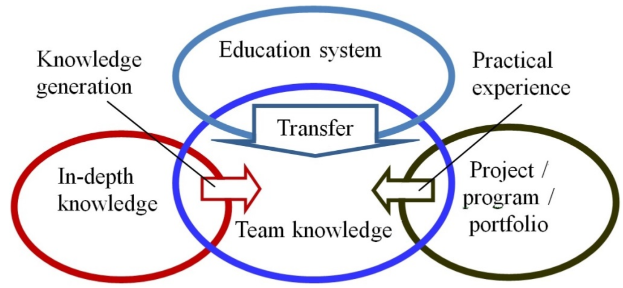

Fig. 2. Cognitive model of interaction of knowledge in project management

Based on the concept of Edward Deming [14] on the existence of the in-depth knowledge system considering the entities – holders or owners of knowledge: project team, customer and system of education and training, we build the iconographic model of the interaction of knowledge in the project management system (Fig. 2). This model has the cognitive properties – it allows exploring the features of knowledge management using the Markov chain [13].

5. Development of the model of interaction of knowledge with Markov chain

We transform the diagram shown in Fig. 2 in a homogeneous Markov chain (Fig. 3), discrete states of which shown in Fig. 3 correspond to the holders of knowledge, which are depicted in Fig. 2: S_1 – customer, S_2 – project team, S_3 – in-depth knowledge, S_4 – education system. Note that the tagged directed graph which is shown in Fig. 3, reflects not the physical interaction of knowledge holders, but the secondary projection of this communication on the knowledge space.

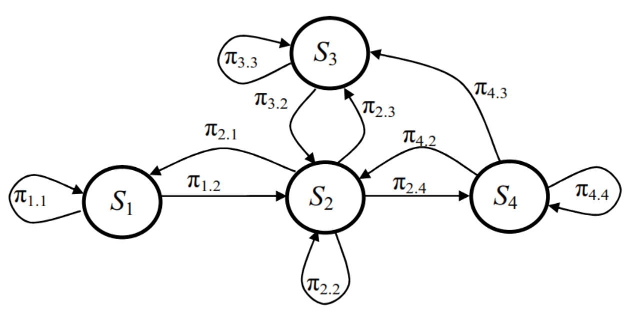

Fig. 3. The graph of the Markov chain

The state probabilities are determined by the equation:

$$\begin{Vmatrix} p_1(k+1) \\ p_2(k+1) \\ p_3(k+1) \\ p_4(k+1) \end{Vmatrix}^T = \begin{Vmatrix} p_1(k) \\ p_2(k) \\ p_3(k) \\ p_4(k) \end{Vmatrix}^T \cdot \begin{Vmatrix} \pi_{1.1} & \pi_{1.1} & 0 & 0 \\ \pi_{2.1} & \pi_{2.2} & \pi_{2.3} & \pi_{2.4} \\ 0 & \pi_{3.2} & \pi_{3.3} & 0 \\ 0 & \pi_{4.2} & \pi_{4.3} & \pi_{4.4} \end{Vmatrix}, \tag{1}$$

where $p_i(k)$ – the state probabilities, i=1, 2, 3, 4; k – step; π_{ij} – transition probabilities, i=1, 2, 3, 4; j=1, 2, 3.

For each k-th step righteous expression

$$p_1(k)+ p_2(k)+ .... + p_n(k)=1,$$

as $p_1(k)$ to $p_4(k)$ – the probability of inconsistent events that form a complete group.

The values $p_1(k)$ to $p_4(k)$ is the probability of homogeneous states of the Markov chain with discrete time in which the transition probabilities π_{ij} do not depend on the number of steps. There is also a possibility of a delay of the system in this state at each k step. In the graph, arrows are affixed only to those transitions which transition probabilities are not zero [13].

The system of interaction of knowledge in project management includes 4 states (processes) shown in the directed graph of the Markov chain (Fig. 3). These discrete states correspond to the holders of knowledge: S_1 – customer, S_2 – project team, S_3 – in depth knowledge, S_4 – education system. For any state s{s∈1, 2, 3, 4}, the total time T_s of communications with other states can be represented as the sum of the time intervals of communications with these conditions t_{sj}{s∈1, 2, 3, 4; j∈1, 2, 3, 4}:

$$T_s = \sum_{j=1}^{n=4} t_{sj}, \qquad (2)$$

where t_{sj} – time spent in project communication s→j from the state s.

In each of the numbered communications system may be a certain time t_{sj} of the total project execution time. The relation

$$\pi_{sj} = \frac{t_{sj}}{T_s}$$

makes sense probability (frequency) communications for the transition s→j for some state s.

The sum of all transition probabilities for some state *s* is unity:

$$\sum_{j=1}^{n=4} \pi_{sj} = \sum_{j=1}^{n=4} \frac{t_{sj}}{T_s} = \frac{1}{T_s} \sum_{j=1}^{n=4} t_{sj} = 1. \qquad (3)$$

These transition probabilities π_{sj} for any state s{s∈1, 2, 3, 4} represented in each row of the matrix of transition probabilities (1) form a group of incompatible events. This property π_{sj}{s∈1, 2, 3, 4; j∈1, 2, 3, 4} allows investigating the behavior of the system in different variants of combinations of the project uniqueness for the customer and for the project team (like shown in Fig. 1). By changing π_{sj} we can relocate the system into one of the four areas of project types in the degree of uniqueness. For example, for a project team (that meets the state S_2), the project is not unique. Therefore, the value $\pi_{2.2}$ will approach to the unity ($\pi_{2.2}$>0.8), because the whole life time of the project team will be spent to find unique project solutions. In a similar way, we can determine the values of other transition probabilities based on the relation of used resource of time for various combinations of unique projects for the customer and for the project team (Table 2).

The rules for determining the transition probability are shown in the above Table 2. These values can be used as input data for modeling probabilities of change states of the system for projects which correspond to one of four types of uniqueness (Fig. 1).

Table 2

Determination of values of transition probabilities

Character of communication s→j according to resource cost in the time	The value of transition probabilities π_{sj}
The process takes most of the time resource	0.8–1.0
Average of resource time costs	0.3–0.7
Lower time spending	0.1–0.2
Low cost of resource time	0.01
No time resource spending	0

Markov chain transition probabilities for the project environment define its characteristics which vary in discrete time in the form of a set of probability states. Cognitive properties of the model that is based on the Markov chain make it possible to set some specific values of the transition probabilities of the system.

6. Analysis of the results of applying Markov chains for model of interaction of knowledge in project management

Under the analysis of the behavior of project systems which contain various combinations of structures depicted in Fig. 1 (type I–IV). It will also consider the necessity of using training and in-depth knowledge. Since the project is a key element of the knowledge space, the paradigm of "lifelong learning" can be justified only if the project is successful.

6. 1. The variation of the state probabilities of the system for the project which is not unique for the customer and the project executor (Fig. 1, type IV)

We explain the transformation of the conditions of interaction of the project entities in certain values π_{ij} of transition probabilities, for example, the formation of values of matrix elements of transition probabilities (4). The project is unique neither to the project team, nor for the customer. Therefore, the interaction between holders is minimal – $\pi_{1.2}$=0.1. This level of communication with the performer is low. Most part of his time the customer spends on individual work on the project ($\pi_{1.1}$=0.9). Spending time of resource for interaction with the systems of training and in-depth knowledge absent, so $\pi_{1.3}$=0 and $\pi_{1.1}$=0. Based on the rules given in Table 2, we have determined the transition probabilities (4) for other states.

When the customer and the project team are fully knowledgeable about the features of the project, in this case, the matrix of transition probabilities may look like:

$$\left\|\pi_{i.j}\right\| = \begin{Vmatrix} 0.9 & 0.1 & 0 & 0 \\ 0.1 & 0.88 & 0.01 & 0.01 \\ 0 & 0.01 & 0.99 & 0 \\ 0 & 0.01 & 0.01 & 0.98 \end{Vmatrix}. \qquad (4)$$

The simulation results of this combination of project uniqueness, when both the customer and the project team have skills and know what to do are shown in Fig. 4. The level of uncertainty of the project is negligible, so the state probabilities, proportional to the time of the state of the customer p1(k) and the performer p2(k) are almost identical at step 20, which means equal cooperation. The state probabilities p3(20) and p4(20) are close to zero, so that mean: this part of the system of training and "in-depth knowledge database" is not necessary (Fig. 4).

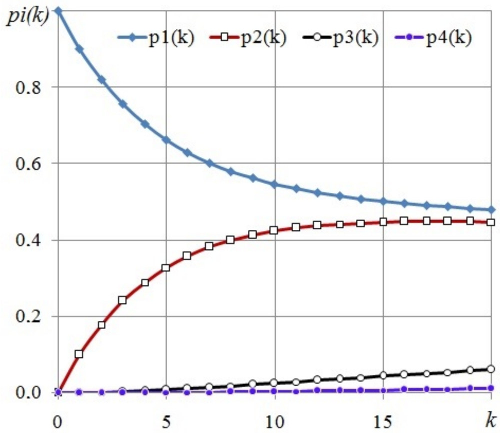

Fig. 4. The variation of the state probabilities for the project when it is not unique for the customer and the performer

6. 2. The variation of the state probabilities of the system when the project is unique for the customer and it is not unique for the performer (Fig. 1, type I)

We use the rules from Table 2. If the project is unique for the customer, we can take $\pi_{1.2}$=0.8 and $\pi_{1.2}$=0.2. Since the project team has full knowledge about the features of the project, the value $\pi_{2.2}$>0.8. It will fit most cost of resource time. Under these conditions, the matrix of transition probabilities may look like:

$$\left\|\pi_{i.j}\right\| = \left\|\begin{array}{cccc} 0.2 & 0.8 & 0 & 0 \\ 0.1 & 0.88 & 0.01 & 0.01 \\ 0 & 0.01 & 0.99 & 0 \\ 0 & 0.01 & 0.01 & 0.98 \end{array}\right\|. \quad (5)$$

Under such conditions, we get a different state probability distribution than that shown in Fig. 5. The load on the project team p2(k) increases, but it, unfortunately, does not increase the time to complete the project and the value p1(k) decreases. Terms of use of the "In-depth knowledge database" and the education system in the version that is shown in Fig. 5, have not changed in comparison with data (4).

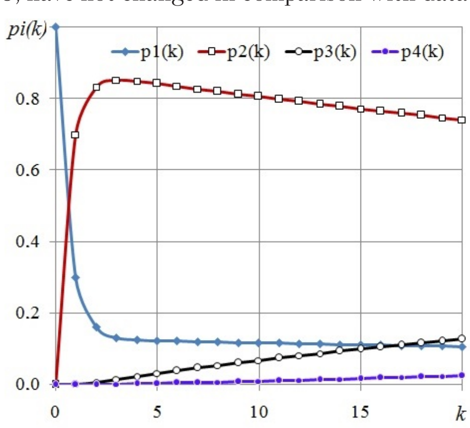

Fig. 5. The variation of the state probabilities of the project when the project is unique for the customer and the project is not unique for the performer

6. 3. The variation of the state probabilities of the system when the project is not unique for the customer, and the project is unique for the performer (Fig. 1, type III)

In the case of such a unique combination, there is the need to identify new transition probabilities π_{ij}. If the project is not unique, the customer does not need to interact with the project team, the value $\pi_{1.2}$, as already mentioned, will be $\pi_{1.2}$=0.1. That is the level of communication with the executor is low. In case of uniqueness, the time for the executor's communication with the customer $\pi_{2.1}$=0.7 increases at the initiative of the executive.

The matrix of transition probabilities is as follows:

$$\left\|\pi_{i.j}\right\| = \left\|\begin{array}{cccc} 0.9 & 0.1 & 0 & 0 \\ 0.7 & 0.28 & 0.01 & 0.01 \\ 0 & 0.01 & 0.99 & 0 \\ 0 & 0.01 & 0.01 & 0.98 \end{array}\right\|. \quad (6)$$

The simulation results show the undesirable probability distribution for the project team: the lion's share of time the project belongs to the customer (Fig. 6). Under such conditions, there is a need to replace the team.

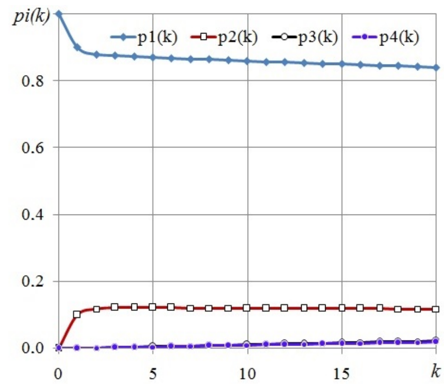

Fig. 6. The variation in the state probabilities of the project when the project is a unique for the performer and it is not unique for the customer

6. 4. The variation of the state probabilities of the system when the project is unique for the customer and for the performer (Fig. 1, type II)

We found out how the system will behave in the event of unique project for the customer and for the project team. For this purpose, we replace the first line (4) with the first line of (5) and the second line – take from (6):

$$\left\|\pi_{i.j}\right\| = \left\|\begin{array}{cccc} 0.3 & 0.7 & 0 & 0 \\ 0.7 & 0.28 & 0.01 & 0.01 \\ 0 & 0.01 & 0.99 & 0 \\ 0 & 0.01 & 0.01 & 0.98 \end{array}\right\|. \quad (7)$$

The data on the trajectory of the project for the transition probabilities matrix (7) also reflect the unwanted system state probability distribution. The executor and the customer are constantly looking for some proposals and solutions on the project from each other (Fig. 7). Under such a combination of uniqueness for both stakeholders, there is a probability of the project failure due to lack of knowledge and competence to implement the project.

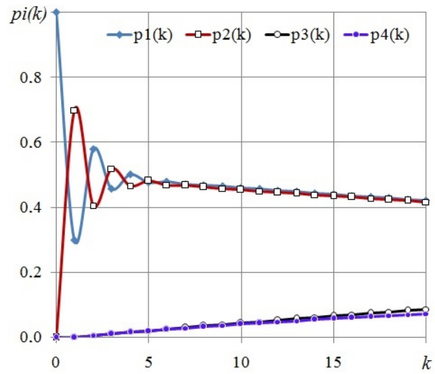

Fig. 7. The variation of the state probabilities of the project when the project is unique for the performer and for the customer, and the systems of "In-depth knowledge" and learning are not used

6. 5. The variation of the state probabilities of the system in case of connection to the project of the system of "in-depth knowledge" and education. The project is unique for the customer and for the performer (Fig. 1, type II)

We determine how the system will behave in the event of "connection" of in-depth knowledge and appeal to the education system to transfer new necessary knowledge to complete the project. Of course, in this case, a part of time will be used for training, rather than direct activities to complete the project.

In the case of "connecting" in-depth knowledge and ppeal to the training system, the matrix of transition probabilities can be:

$$\left\|\pi_{i,j}\right\| = \left\|\begin{matrix} 0.3 & 0.7 & 0 & 0 \\ 0.3 & 0.35 & 0.1 & 0.25 \\ 0 & 0.3 & 0.7 & 0 \\ 0 & 0.3 & 0.1 & 0.6 \end{matrix}\right\|. \quad (8)$$

In the case of connection of "in-depth knowledge" [14] and appeal to the education system, the characteristics of the project team work change (Fig. 8).

The simulation results show that the project execution parameters and characteristics of acquiring new knowledge through knowledge generation in consequence of the use of the "in-depth knowledge system" change significantly (according to E. Deming). Apparently, the system of education, the variation of the state probabilities of which is shown by the curve p4(k), virtually becomes a part of the project.

Using the cognitive model of the results presented in Fig. 4–8, allows justifying the paradigm of "lifelong learning". The knowledge management structure includes some fundamental entities: the customer, the team, training and in-depth knowledge systems of the knowledge owners. These entities are in a constant process of knowledge sharing. The systems of training and in-depth knowledge play a role of generating new knowledge, which was absent in the project environment. The controversy over the fact that any project team initially will not have the required set of competencies can be overcome through lifelong learning [17].

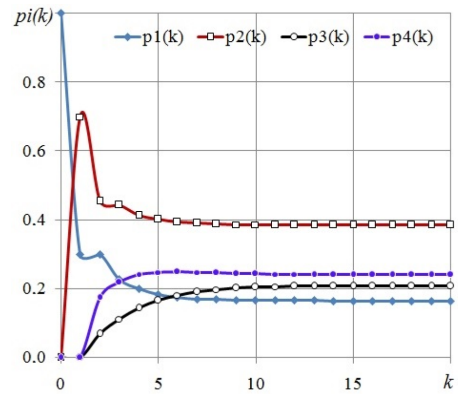

Fig. 8. The variation of the state probabilities for the project when the project is unique for the performer and for the customer and in case of connection of "in-depth knowledge" and appeal to the education system

7. Conclusions

The studies were conducted as a theoretical basis of a new paradigm of "lifelong learning", which is an essential component to ensure efficient operation of the staff:

1. In a theoretical study, it is assumed that the competence and knowledge are continuously improved. These changes are formed through the basic nature of the customer, project team, training system and in-depth knowledge system as the knowledge of the owners transformed in the project environment.

2. The results are the justification for continuing training and acquiring additional education of personnel in the deficit of knowledge that is necessary for the implementation of unique projects. The data obtained using the cognitive model created to show the interaction of knowledge in project management is very important for understanding the approaches to the formation of the project team. For any project team at the start of the unique projects, there is a probability of failure to meet the requirements of completeness of possession of the necessary knowledge and competencies.

3. Continuing education ideally is aimed at balancing between the needs of society and the motivational structure of personality that actually allows implementing necessary mechanisms through the influence of education on the socialization of the individual. The typical structure of knowledge interaction in the field of project management enables to hypothesize about the possibility of using Markov chains to model these systems.

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