DYNAMICS OF KNOWLEDGE ACQUISITION USING A SYNERGISTIC APPROACH IN TRAINING

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Abstract: *This study shows that the knowledge acquisition can be determined in case of need to integrate not only the students' knowledge assessment, but also the methods of teaching. The knowledge acquisition during integrated approach can determine not only the professional development of the entire complex of knowledge, but also the structure of opportunities for formalizing the general development of the education process. The lessons in various disciplines for students of the Faculty of Management and Economics were analyzed. Indicators of development and stratification of acquisition of knowledge by students were received during realization of the synergetic approach in training.*

Keywords: Synergetic approach, training, knowledge dynamics, program acquisition, Faculty of Economics and Management.

Reorganization of educational process in the system of the higher school, proceeding from requirements and the principles of the Bologna declaration, is focused on formation of new type of the active creative person.[1] It actualizes the search of various methods, techniques, means and innovative technologies of training.[2] Besides, the transition to a credit-module education system, which assumes the use of different forms of lessons and types of student training, puts forward new requirements for developing methodological support for students in various types of work of higher education institutions and its control.[3]

The researches have defined that education in the field of economics and management will be full only when students master the

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[1] S. Schnell, S. Prediger, "Multiple representations as tools for discovering pattern and variability-Insights into the dynamics of learning processes", in T. Wassong, D. Frischemeier, P.R. Fischer, R. Hochmuth, P. Bender (eds.), *Mit Werkzeugen Mathematik Und Stochastik Lernen-Using Tools for Learning Mathematics and Statistics*, Wiesbaden, Springer Fachmedien Wiesbaden, 2014, pp. 179-192.

[2] T. Blakely, K. Miller, J. Ojemann, R. Rao, "Exploring the Cortical Dynamics of Learning by Leveraging BCI Paradigms", in C. Guger, B.Z. Allison, G. Edlinger (eds.), *Brain-Computer Interface Research: A State-of-the-Art Summary*, Berlin, Heidelberg, Springer Berlin Heidelberg, 2013, pp. 53-60.

[3] C. Backhage, C. Ojeda, R. Sifa, "Circadian Cycles and Work Under Pressure: A Stochastic Process Model for E-learning Population Dynamics", in P. Haber, T. Lampoltshammer, M. Mayr (eds.), *Data Science-Analytics and Applications*, Wiesbaden, Springer Fachmedien Wiesbaden, 2017, pp. 13-18.

system of knowledge. This system is characterized by a variety of theoretical material that reveals all types of social activities. But this problem is not studied well and requires further scientific researches.

Monitoring and evaluation of students' knowledge is the obligatory component in the learning process.[4] They take place at all stages of the education process, but special importance they gain after studying of any section of the program and completing the level of training.[5] The essence of the verification of the learning results consists in the identification of the level of knowledge acquisition by students, which must correspond to the educational standard of this program and this subject.[6] The key task is the orientation to the final result: competences of graduates in future professional activity.[7] The relevance and importance of the correct organization of knowledge control during the training of specialists follows from it.

Literature review

A significant number of researches paid attention in their studies to the problems of control in the pedagogical process. Questions of the modular-rating control system were studied in some researches.[8] Test control in the system of assessing knowledge was made on the academic discipline "Theory of games, taking into account the latest technology".[9]

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[4] D. Soni, M. Hanmandlu, H.C. Saini, "A Machine Learning Approach for User Authentication Using Touchstroke Dynamics", in A.K. Somani, S. Srivastava, A. Mundra, S. Rawat (eds.), *Proceedings of First International Conference on Smart System, Innovations and Computing*, Singapore, Springer Singapore, 2018, pp. 391-410.

[5] A.T. Ching, T. Erdem, M.P. Keane, "Empirical Models of Learning Dynamics: A Survey of Recent Developments", in B. Wierenga, R. van der Lans (eds.), *Handbook of Marketing Decision Models*, Cham, Springer International Publishing, 2017, pp. 223-257; E. M. Akhmetshin, S. I. Makulov, I. A. Talysheva, S. Y. Fedorova, S. Gubarkov, "Overcoming of intercultural barriers in the educational environment", in *Man in India*, 97(15) (2017), 281-288.

[6] X. Xiao, P. Pham, J. Wang, "Dynamics of Affective States During MOOC Learning", in E. André, R. Baker, X. Hu, M.M.T. Rodrigo, B. du Boulay (eds.), *Artificial Intelligence in Education*, Cham, Springer International Publishing, 2017, pp. 586-589.

[7] R. Capello, C. Lenzi, "The dynamics of regional learning paradigms and trajectories", in *J Evol Econ.*, (2018), doi:10.1007/s00191-018-0565-5.

[8] A. Venkatraman, R. Capobianco, L. Pinto, M. Hebert, D. Nardi, J.A. Bagnell, "Improved Learning of Dynamics Models for Control", in D. Kulić, Y. Nakamura, O. Khatib, G. Venture (eds.), *2016 International Symposium on Experimental Robotics*, Cham, Springer International Publishing, 2017, pp. 703-713.

[9] N. Steils, S. Hanine, "Creative Contests: Knowledge Generation and Underlying Learning Dynamics for Idea Generation (An Abstract)", in P. Rossi (ed.), *Marketing at*

Assessment of rhythmic readiness for students' tests (on the example of the discipline "Strategic Planning") was studied also by Maani.[10]

According to Bentebbaa,[11] the qualitative appraisal activity can improve the quality of the teaching and educational process, which generates the need for a student or teacher to receive information about whether or not the quality of the student's knowledge and skills on the subject meets the requirements of the program. The purpose of this activity is to monitor the progress of students, and the subject of evaluation activity is the system of knowledge and skills of the student.[12] Consequently, the urgency of the problem and its practical importance caused the need to conduct a research according to the plan of the department's scientific research work.

Materials and methods

The purpose of the research is to investigate the level of theoretical knowledge of freshmen in the subject "Theory of games".

Due to the purpose of the study, the following tasks were set:

1. On the basis of expert assessments, it is necessary to determine the level of theoretical knowledge of students of the subject "Theory of games".

2. It is necessary to develop rating scales from the theoretical knowledge of this discipline for the freshmen of the Faculty of Management and Economics.

The following methods were used in the work for solving mentioned tasks: analysis and generalization of literary sources on the research topic, studying the content of the curriculum of the course "Theory of Games", testing of level of theoretical knowledge of students of this discipline, standard methods of mathematical statistics during processing results of a research.

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the *Confluence between Entertainment and Analytics*, Cham, Springer International Publishing, 2017, p. 221.

[10] K. Maani, "System Dynamics and Organizational Learning", in R.A. Meyers (ed.), *Encyclopedia of Complexity and Systems Science*, Berlin, Heidelberg, Springer Berlin Heidelberg, 2018, pp. 1-14.

[11] S. Bentebbaa, "Moroccan Family Businesses: Specific Attributes, Logics of Action and Organizational Learning Dynamics", in S. Basly (ed.), *Family Businesses in the Arab World: Governance, Strategy, and Financing*, Cham, Springer International Publishing, 2017, pp. 63-81.

[12] M.R. Gearty, D. Coghlan, "The First-, Second- and Third-Person Dynamics of Learning History", in *Syst Pract Action Res.*, (2017), doi:10.1007/s11213-017-9436-5.

Results and Discussion

Analysis of the scientific literature shows that an important role in ensuring the high quality of education and the formation of competitive specialists under the Bologna process conditions belongs to the system for monitoring and evaluation of students' academic achievements in the conditions of a credit-module education system.[13] The introduction of a credit-module education system is the important factor for stimulating the effective work of either teacher or student.[14] Transparency, objectivity, individuality are the main principles of assessing knowledge and skills in this system of educational process organization.[15]

In the system of education in higher educational institutions professional motivation is considered to be a set of factors and processes which, when they are reflected in consciousness, induce and direct the person to the study of future professional activity[16] After making analysis of the information on the formation of professional motivation for educational activities, we determined conditions, which could affect the formation of positive motives for learning activity.[17] Such conditions are:

1) professional level of the teacher (desire and ability to teach);

2) the attitude towards the student as a competent person;

3) assistance in self-determination of the student, development of positive emotions of the student;

4) organization of studying as a process of cognition;

5) use of methods that stimulate learning and cognitive activity;

6) awareness of the nearest and final goals of studying;

7) professional orientation of educational activity.

Professional motivation as a character of a person is a system of goals and needs that motivate students to actively master knowledge,

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[13] H. Kato, "The Middle to Upper Paleolithic Transition in Siberia: Three Regional Sketches for Replacement", in T. Akazawa, Y. Nishiaki, K. Aoki (eds.), *Dynamics of Learning in Neanderthals and Modern Humans Volume 1: Cultural Perspectives*, Tokyo, Springer Japan, 2013, pp. 93-103.

[14] J.A. Hertz, "Statistical dynamics of learning", in L. Garrido (ed.), *Statistical Mechanics of Neural Networks*, Berlin, Heidelberg, Springer Berlin Heidelberg, 1990, pp. 137-153.

[15] N. Roberts, G. Blakeslee, W. Barowy, "The dynamics of learning in a computer simulation environment", in *J Sci Teacher Educ.*, 7(1) (1996), 41-58.

[16] J.J. Buchanan, "Learning a single limb multijoint coordination pattern: the impact of a mechanical constraint on the coordination dynamics of learning and transfer", in *Exp Brain Res.*, 156(1) (2004), 39-54.

[17] A. Presbitero, B. Roxas, D. Chadee, "Effects of intra- and inter-team dynamics on organisational learning: role of knowledge-sharing capability", in *Knowl Manag Res Pract.*, 15(1) (2017), 146-154.

master skills and experiences, and a conscious attitude toward the profession.

Nowadays researchers do not have any doubts that the progress of students mainly depends on the development of professional motivation, but not only from natural abilities. There is a complex of system of interrelationships between these two factors. But today the science has not yet developed a unified approach to solving the problem of motivating students' behavior, the terminology has not been established, the basic concepts have not been formulated clearly yet.[18]

If we talk about student learning activities, under professional motivation we understand a combination of factors and processes that induce and guide the individual to the study of future professional activity.[19] Professional motivation is an internal factor in the development of professionalism and personality. At the same time, under the motives of professional activity we understand the awareness of the actual needs of the individual (higher education, self-knowledge, self-development, social status, professional development).

In the university at the Faculty of Economics and Management in the training of specialists of "Bachelor" educational and qualification level such discipline as "The theory of games" is studied.

According to the curriculum, which was developed by the author, the structure of this discipline requires monitoring of the educational achievements of students in the field of theory of games and practical training. Theoretical and practical knowledge and skills are valued in three meaningful modules, which the student should receive during the semester and make 100 credits: of which the current control is 70 credits, the final control is 30 credits (the form of control is the examination).

83 freshmen, who study such courses of the program specialization as "Organizational Culture" (OC), "Organizational Culture and Management" (OCM), "National Economy" took part in the experiment. The course "Theory of games" is the final course of modular control. According to the provision on the credit-modular system of the organization of the educational process, students who receive at least 50 credits on some discipline on a 100-point scale (A, B, C, D, E on the ESTS scale) are assessed without passing the exam.

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[18] Q. Fu, P. Gu, X. Li, J. Wu, "Iterative learning control approach for consensus of multi-agent systems with regular linear dynamics", in *Sci China Inf Sci.*, 60(7) (2017), 79202.

[19] R.M. French, Y. Glady, J.-P. Thibaut, "An evaluation of scanpath-comparison and machine-learning classification algorithms used to study the dynamics of analogy making", in *Behav Res Methods.*, 49(4) (2017), 1291-1302.

However, students, if they wish, can take the exam in order to increase their marks (rating). The experts were the leading lecturers of the department, who had experience of pedagogical work at least15-35 years.

Examination tests were developed in accordance with the studying and working programs and included a complex structure of control of knowledge, skills and abilities of students.

All examination papers consisted of three questions and were distributed to:

- general questions from the theory of games - that is, questions on the history of the development of theory of games, the game and its features, the place of game theory in the system of management consulting, educational, optimizing, organizational importance of the theory of games, peculiarities of the theory of games with users of different social groups, the pedagogical classification of theory of games. The theory of games in the class time, off-hour and extra-curricular time, the compilation of the provision and programs of interaction such as "Intellectual tasks" and others;

- questions of methodology and organization of the theory of games and preparation for the lesson, the selection of the lesson, preparation of a place for the lesson, preparation of technical means of studying, time marking, the explanation of the lesson, the distribution on focus groups, the definition of assistants, consultants, the management of the process of the lesson, the measure of the study load in the class, the summarizing the results of the lesson, the end of the lesson, and so on;

- the content component - the student's answer includes knowledge of the theory of games according to the scheme: the name of the component, tasks that are solved in the component, the duration of the lesson and its intensity, the contents of the lesson, the rules, the learning algorithm, organizational and methodological instructions for the lesson.

The research of the assessment of theoretical knowledge of students was carried out separately on three questions in the examination paper. The method of mathematical statistics was used to determine the indicators of the assessment of the theoretical knowledge of students. It was defined: arithmetical average (X); root-mean (σ), standard error of the arithmetic average (m), coefficient of variation (V) (Table 1).

Table 1: Indicators of theoretical knowledge
of students of the discipline "Theory of games"

Components of theoretical knowledge on the theory of games	Educational program specialization	Indicators			
		X	σ	± m	V
Theory of games	Organizational culture (n=49)	3,32	0,67	0,09	20,2
	Organizational culture and management (n=16)	3,5	0,57	0,14	16,3
	National economy (n=20)	3,3	0,8	0,18	24,2
Theoretical knowledge on the methodology and organization of the theory of games	Organizational culture (n=49)	3,2	0,67	0,09	20,9
	Organizational culture and management (n=16)	2,4	0,57	0,14	23,8
	National economy (n=20)	3,15	0,8	0,18	25,4
A meaningful component of the theory of games	Organizational culture (n=49)	3,53	0,45	0,06	12,7
	Organizational culture and management (n=16)	3,94	0,57	0,14	14,5
	National economy (n=20)	3,7	0,53	0,11	14,3

The law of normal distribution of test results was used in order to solve this problem. The sigmoid-like (σ-shaped) 5-point scales were developed by using the rule of three sigma on the Gaussian curve. In the 5-point scale, the value of the result for theoretical knowledge $X \pm 0.5\ \sigma$ was taken as the average rate; $X \pm 1,0\ \sigma$ – was considered below average or above average rate; $X \pm 1,5\ \sigma$ – is considered as low or high rates.

In the Table 2 we can see the standards for assessing the theoretical knowledge of students, calculated on a 5-point sigmoid scale.

Table 2: The standards for assessing the theoretical knowledge of students in the Faculty of Management and Economics

Levels of theoretical knowledge of students	Educational program specialization		
	Organizational culture (n=49)	Organizational culture and management (n=16)	National economy (n=20)
Theory of games			
High	5,0 - 4,33	4,93 - 4,37	5,0 - 4,51
Above average	4,32 - 3,67	4,36 - 3,79	4,5 - 3,71
Average	3,66 - 2,98	3,78 - 3,22	3,7 - 2,9
Below average	2,97 - 2,32	3,21 - 2,64	2,89 - 2.1
Low	2,31 - 1,64	2,63 - 2,07	2,09 – 1,3
Theoretical knowledge on the methodology and organization of game theory			
High	4,88 - 4,21	4,83 - 4,27	5,0 - 4,36
Above average	4,2 - 3,56	4,26 - 3,69	4,35 - 3,56
Average	3,54 - 2,86	3,68 - 3,12	3,55 - 2,75
Below average	2,85 - 2,20	3,11 - 2,54	2,74 – 1,95
Low	2,19 - 1,52	2,53 - 1,97	1,94 – 1,15
A meaningful component of game theory			
High	4,66- 4,22	5,0 - 4,81	5,0 - 4,50
Above average	4,21 - 3,77	4,80 - 4,23	4,49 - 3,98
Average	3,76 - 3,30	4,22 - 3,66	3,97 - 3,43
Below average	3,29 - 2,85	3,65 - 3,08	3,42 - 2,91
Low	2,84 - 2,40	3,07 - 2,51	2,90 – 2,37

Note: Further in the text, the following abbreviation as "Organizational Culture" (OC), "Organizational Culture and Management - OCM"; "National economy" – NE - will be used.

The received norms for evaluating the theoretical knowledge of the theory of games made it possible to test their effectiveness among students attending the Faculty of Economics and Management in the 2017-18 school years. Thus, by analyzing the results of knowledge on the issues that are included in the "Theory of games" it was revealed that most students showed an average level: in the course "Organizational Culture" the index is 67.3%, in the course "Organizational culture and management" – it is 62.5%, and students who study the program specialization course "National Economy" have the index 55%. A quarter of students 25% of the program specialization course "Organizational Culture and Management" showed higher than the average level, those, who study "National Economy" had 20%, and students of the "Organizational Culture" course had 14 %. Indicators were - 15%; 12.5%; 12.2%, respectively, "National Economy", "Organizational Culture", "Organizational Culture and Management" showed a high level of knowledge in the theory of games. Insignificant figures of 6.1% and 5% were received in accordance with the program specialization "Organizational culture and management" and "National economy", which corresponds to the level - below the average.

Assessment of students' knowledge on the second issue - "The methodology and organization of the theory of games" revealed also the highest indicators with an average rate, respectively – it was 75,5 % on the program specialization "Organizational Culture", it was 68,7% on the program specialization "Organizational culture and management" and it was 65% on   el above average, so for students of "Organizational culture and management" it was - 18.8%, for students of "Organizational Culture" it was - 10.2%, and of "National Economy" - 10%. The third place takes the high level of knowledge, respectively – it was 12.5% in "Organizational Culture and Management", it was 10% in "National Economy", and 8.2% showed students of the specialization "Organizational Culture".

Knowledge received on the third issue revealed that students of the program specialization "Organizational Culture" have such indicators: with an average level there were 63.3%, the above average showed 20.4% of students and 16.3% of students correspond to a high level. The students of the program specialization "Organizational culture and management" have such indicators: 37.5% showed an average level,

31.25% had above average, and the same percentage was detected with a high level. The program specialization "National Economy" showed that 50% of students have an average level of the content component, 30% - above the average, 20% - a high level.

At the same time, it was found, and we consider it positive, that there were no indicators with low level in each program specialization as "Organizational Culture", "Organizational culture and management", "National Economy". Also, positive indicators were received for the content component. So, there are no indicators below the average level.

For the first time, the normative assessments of theoretical knowledge of students of the Faculty of Management and Economics in the discipline "Theory of games" were developed. Summarizing all the mentioned above, we can conclude that, in general, the level of theoretical knowledge and practical skills of students is satisfactory.

The proposed standards for assessing the theoretical knowledge of students of the Faculty of Management and Economics are aimed at revealing the potential of a student of the higher educational institution and improving the quality of professional training of specialists.

Of course, the conducted research does not find exhaustive solution of all the issues of this problem. The orientation of further research consists in need to develop special methodological recommendations that will contribute to the growth and enhancement of theoretical knowledge and practical skills of students in the subject "Theory of games".