Strategies for students’ lean competencies formation in the educational process of the university

S V Mishina
Bunin Yelets State University, 28, Kommunarov St, Yelets, Lipetsk region, Russian Federation

E-mail: svmishina2017@mail.ru

Abstract. The article examines efficiency of various strategies for students’ lean competencies formation in the educational process of the university. The relevance of the issue is justified by the fact that university graduates with developed lean competencies are in high demand on the job market. In the present article lean competencies are formally described requirements for personal, professional and other skills and qualities of students, action plans, methods and algorithms of actions related to lean production in a specific area. The solution to the problem indicated is carried out via analysing results of the pedagogical experiment. During the experiment the effectiveness of four strategies of students’ lean competencies formation was tested: formal education, practical training, hidden curriculum, mixed strategy. 208 3rd and 4th year students mastering undergraduate programs in ”Economics (Accounting, Analysis and Audit),” ”Economics (Finance and Business Analytics),” ”Management (Production Management),” ”State and Municipal Administration (Regional and Municipal Administration) were surveyed during the experiment.” The study identified the following components of lean competencies: 1) knowledge and understanding; 2) skill; 3) implementation. These components correspond to the first three levels of lean competencies according to international classification, namely fundamental lean competencies: knowledge and understanding - level of awareness (1A); skill - level of diagnostics and analysis (1B); implementation - level of improvement and implementation (1C). Diagnostic tools included testing, expert evaluation of case solutions, and lean projects development. Statistical data processing was carried out on the basis of a Fisher F-test variance analysis for three or more independent groups using Statistica 10 and SPSS 20 software.

1. Introduction
Lean production technologies, or lean technologies, are an integral part of management system of modern production or modern organization. According to many modern researchers and advocates of these technologies (J Krafcik [1], K Sekine [2], J P Womack and D T Jones [3]), the center of management that implements the principles of lean production becomes the man and the community. In this respect, the question of strategies for training staff on the basis of lean production proves to be relevant. G Hutchins justified the dilemma in solving this problem: what is more effective on-the-job training or higher education? [4] It is very difficult to get an unambiguous answer to this question, since the effectiveness of two training strategies depends on a number of factors. Nevertheless, the need to develop lean competencies of future specialists on the level of higher education is justified by employers’ need in competitive workforce with the required competencies.
The concept of lean competence is the main term in the study. When determining the volume and content of this concept we focus on GOST P 57523-2017 «Lean production. Personnel Training System Manual” [5]. Lean competences are formally described requirements for personal, professional and other skills and qualities of students, action plans, methods and algorithms of actions related to lean production in a specific area. On the international level, the Center for Lean Production Research at Cardiff University has developed a Lean Production Competence System (LCS) [6]. According to the basic guidelines of this organization, individual acquisition of lean competencies with subsequent certification can be carried out in various ways: formal training in an educational institution or directly by a company, and practical training which involves independent training, and on-the-job training.

This article examines the effectiveness of various strategies of students’ lean competencies development in the educational process of the university.

2. Materials and methods

The study of various strategies of the students’ lean competencies efficiency in the educational process of the university was carried out through the method of pedagogical experiment. The research was based in the Institute of Law and Economics of Yelets State University named after I.A. Bunin. Respondents were 3rd and 4th year students mastering undergraduate programs 38.03.01 "Economics (Accounting, Analysis and Audit),” 38.03.01 "Economics (Finance and Business Analytics),” 38.03.02 "Management (Production Management),” 38.03.04 "State and Municipal Administration (Regional and Municipal Administration).” During the pedagogical experiment, the effectiveness of four strategies of students’ lean competencies formation was tested: formal training, practical training, the hidden curriculum, mixed. Let us consider these strategies in more detail.

The formal training strategy was implemented in the form of elective course ”Lean production.” The scope of the discipline is 144 contact hours, 4 credit units. The content of the course was developed taking into account GOST P 57523-2017 ”Lean production. Manual on Personnel Training System,” as well as on the basis of A V Vyalov training manual [7]. The content of the course includes 8 modules: ”Lean production: philosophy and basic concepts,” ”Value,” ”Value stream,” ”Losses in the value stream,” ”Improvement of the value stream,” ”System of lean production management,” ”Methods and tools of lean production: standardized work (POC); Workspace Organization (5S); visualization,” ”Suggestions for improvement.”

In the process of elective course teaching, both active and interactive methods and forms of training were applied: problem method, business games, decision-making games, discussion methods, workshops. A special role in implementing the content of the elective course is a process factory and case method.

A process factory is an interactive learning method specific to lean learning. Methodologically it is close to such methods as business game and training. The essence of the process factory is that participants are immersed in any production process with specified roles. According to the presented algorithm, they are offered to perform a system of operations to obtain a specific result in a short time. Then the participants analyze the process, determine losses, improve the process and act it out according to the new model. As a result, participants are convinced in the effectiveness of the improvements made. As a part of the elective course, two process factories were implemented. At the beginning of training, a process factory was carried out without taking into account subject specifics, it acted as a motivation. At the end of training, the process factory was carried out taking into account bachelors’ majors.

The case method was used in the form of distance learning. Cases were devoted to such problems as determining losses in the value stream, finding errors in the compilation of standard operational maps, compiling standards and algorithms.

The strategy of practical training was employed during the on-the-job training of students. In the implementation of this strategy, methods such as workplace training, mentoring, and an individual educational route were used. Students were placed in enterprises and organizations where lean production technologies are used. Among the employees of the organization or enterprise, students were assigned to mentors (usually members of the change teams), who immersed in the nature of lean
production during the internship. Obtaining practical experience was planned and recorded in the individual educational routes of students, which had been developed before the placement together with students, mentor and curator of the job placement from the university staff. Each stage of the placement was subjected to professional reflection with the placement supervisor.

Of particular interest is the strategy of hidden curriculum. The hidden curriculum is a channel for transmitting educational effect that goes beyond educational standards and curricula. The subject of transmission is values, social attitudes, traditions, certain innovations, etc., which determine primarily personal development, the specifics of the processes of socialization and professional identification of students.

In the works of M W Apple [8], B B Bernstein [9], P Bourdieu [10] the hidden curriculum is marked with a negative semantic load, since it acts as a mechanism for influencing the nature of personal development without "notifying" students, thereby violating individual freedoms.

In the works of M Jelich, V Zorich [11], I S Nechitaylo [12], A A Polonnikov [13], the hidden curriculum is interpreted as a technological and methodological solution to problems that go beyond the framework of formal state standards, plans, programs, representing a curriculum that contains certain aspects of the newly formed structure of subjects, the content of which is determined by the traditional curriculum.

In the present study, the hidden curriculum refers to as a contextual educational technology, functioning of which is based on the immersion of students in an active social context through the systematic introduction of lean production components into the teaching content, as well as through the forced use of active methods and means of organizing the learning process (S V Mishina, S V Shcherbatykh [14]).

In the context of the present research the following resources of students’ learning activity were involved: academic course "Management", "Finance", "Econometrics", "Marketing", "Labor economics", "Money, credit, banks", "Economy of firm", "Accounting, financial accounting", "Macroeconomic planning and forecasting", "Taxes and taxation", "The complex analysis of economic activity" (bachelor degree 38.03.01 - "Economy" (profile) "Accounting, analysis and audit"); "Finance", "Management", "Econometrics", "Marketing", "Labor economics", "Money, credit, banks", "Federal taxes and collecting", "Accounting", "Tax accounting and reporting", "Regional taxes and fees", "Accounting financial statements", "The economic analysis" (bachelor degree 38.03.01 - "Economy" (profile) "Taxes and taxation").

The mixed strategy involved the organic use of formal, hands-on learning and hidden curriculum strategies.

To study the effectiveness of each of the strategies for the formation of lean competencies of students 4 experimental groups were identified. In the process of implementing the pedagogical experiment in pilot group No. 1 (58 students), the strategy of formal education was implemented, in pilot group No. 2 (51 students) - the strategy of practical training, in pilot group No. 3 (49 students) - the strategy of hidden curriculum, in pilot group No. 4 (47 students) - the mixed strategy was employed.

When developing the criterion of the study, lean practice competence assessment criteria prescribed by GOST P 57523-2017 "Lean Production" were applied. Personnel training system manual": 1) advantages of lean production (applying knowledge and practices); 2) principles of lean production (value loss), stream (value stream), pulling, desire for excellence (improvements, standardization, opportunities for improvements); 3) management of stakeholders (communication skills, changes at the individual level, changes at the organizational level); 4) measurement of improvement process (indicators of improvements); 5) creative thinking; 6) visual management; 7) workplace optimization; 8) process improvements based on teamwork; 9) implementation of lean production (implementation planning); 10) data analysis; 11) risk analysis; 12) stability; 13) motivation of employees.

The following were identified as components of lean competencies: 1) knowledge and understanding; 2) skill; 3) implementation. These components correspond to the first three levels according to international classification of lean competencies, namely, fundamental lean competencies:
knowledge and understanding - level of awareness (1A); skill - level of diagnostics and analysis (1B); implementation - level of improvement and implementation (1C).

Diagnostic tools applied: testing, expert evaluation of case solutions, development of lean projects.

Statistical data processing was carried out on the basis of a Fisher F-test variance analysis for three or more independent groups using Statistica 10 and SPSS 20 software.

3. Results and discussion

The results of the pedagogical experiment confirmed the hypothesis put forward about the heterogeneous influence of learning strategies on the formation of lean competencies of students (table 1).

Table 1. Formation of students’ lean competencies by levels.

| Pilot group  | Awareness level (1A) | Diagnosis and analysis level (1B) | Improvement and implementation level (1C) |
|--------------|----------------------|-----------------------------------|------------------------------------------|
| Pilot group №1 | 79.31%               | 20.69%                            | 0.00%                                    |
| Pilot group №2 | 11.77%               | 84.31%                            | 3.92%                                    |
| Pilot group №3 | 48.98%               | 44.90%                            | 6.12%                                    |
| Pilot group №4 | 29.79%               | 44.68%                            | 25.53%                                   |

The strategy of formal education allows to firmly develop the level of awareness of lean competencies among students (79.31%). Some students demonstrated higher results corresponding to the level of diagnosis and analysis (20.69%) when mastering the elective course. However, the level of improvement and implementation was not achievable for anybody in the pilot group No. 1. The strategy of practical training showed effectiveness in forming the level of 1B (84.31% of students of pilot group No. 2), a small part of students mastered lean competencies in practical training at the level of 1C (3.92%). A more balanced distribution of results is observed using the hidden curriculum strategy: approximately equal groups of students mastered lean competencies at the 1A (48.98%) and 1B (44.90%) levels. The group of students who have a level of 1C turned out to be more numerous in the strategy of hidden curriculum than in the use of strategies of formal and practical training (6.12%). The mixed strategy gave the best results: the level of 1A was shown by 29.79% of students of pilot group No. 4, the level of 1B - 33.68%, the level of 1C - 25.53%.

Table 2 represents the results, evaluating the effect of each of the strategies tested in the experimental groups on the lean competence components derived from the Fisher F-test dispersion analysis.

Table 2. Statistical significance of the components of student’s lean competencies formation (variance analysis according to the Fisher F-criterion).

| Components                | F_{emp}; F_{cr}=265 at p≤0.05; F_{cr}=388 at p≤0.01 |
|---------------------------|-----------------------------------------------------|
| Knowledge and understanding| Pilot group №1: 561; Pilot group №2: 214; Pilot group №3: 496; Pilot group №4: 534 |
| Skills                    | Pilot group №1: 315; Pilot group №2: 428; Pilot group №3: 398; Pilot group №4: 628 |
| Implementation            | Pilot group №1: 122; Pilot group №2: 299; Pilot group №3: 276; Pilot group №4: 312 |

In pilot group No. 1, formal learning strategy had a statistically significant impact on the formation of knowledge and understanding component of lean competencies, inefficiency of this strategy to form the implementation component was also confirmed. The strategy of practical training showed statistically significant efficiency in forming the component of skill and inefficiency in forming the component of knowledge and understanding of lean competencies of pilot group No. 2. The most effective for the formation of knowledge and understanding skills of students’ lean-competencies were
demonstrated by the strategy of hidden curriculum and the mixed strategy, with slightly higher values of the latter strategy. When determining the effectiveness of strategies applied in pilot groups No. 3 and No. 4 to form the implementation component of lean competencies of Femp students, it was recorded in the ambiguity zone.

4. Conclusions
The pedagogical experiment demonstrated the high efficiency of the hidden curriculum and mixed strategies in the formation of students lean-competencies in the educational process of the university, but the limited isolated use of formal and practical learning strategies. Each of the proven strategies has some shortcomings.

A strong organizational resource is needed to implement the hidden curriculum strategy since this strategy requires coordination at planning and implementation levels in terms of the content and training technologies for a number of teachers. The mixed strategy has proved to be quite resource-intensive. Simultaneous application of other strategies within the framework of mixed strategy can harm other aspects of training activities in contrast to the formation of students’ lean competencies.

References
[1] Krafick J 1988 Triumph of the Lean Production System Sloan Management Review, MIT 30(1) 41-52
[2] Sekine K 1992 One-Piece Flow. Cell Design for Transforming the Production Process (Cambrigde, Massachusetts, Norwalk, Connecticut: Productivity Press)
[3] Womack J P and Jones D T 2003 Lean Thinking. Banish Waste and Create Wealth in Your Corporation (New York at al.: Free Press)
[4] Hutchins G 2001 Learn Lean Quality Progress 9 97
[5] GOST R 57523-2017 Lean production. Guide for personnel training system Approved and put into effect by the Order of the Federal Agency for Technical Regulation and Metrology dated June 30, 2017 N 648-st
[6] Website of Public company “Lean Competency System” Retrieved from: www.leancompetency.org
[7] Vyalov A V 2014 Lean production: a tutorial (Komsomolsk-on-Amur: FGBOU VPO “KnAGTU”)
[8] Apple M W 1990 Ideology and Curriculum (New York and London: Psychology Press)
[9] Bernstein B B 2000 Pedagogy, Symbolic Control, and Identity: Theory, Research, Critique (Rowman & Littlefield)
[10] Bourdieu P 1984 Homo academicus (Paris: Minuit)
[11] Jelich M, Zorich V 2017 Current concept of curriculum in preschool education system in Montenegro Innovations in Education XXX(4) 14-34
[12] Nechitaylo I S 2015 Research methods of implementation of a hidden curriculum through the method of “experimental lecture” Scientific Works. Sociology 246(258) 31-7
[13] Polonnikov A A 2011 “Hidden curriculum” as a subject of educational research and practice. Relga. Scientific and Cultural Journal 6(224) URL: http://www.relga.ru/Environ/Webobjects/igu-www.woa/wa/Main?textid=2875
[14] Mishina S V and Schcherbatykh S V 2019 Development of professionally significant qualities of future economists by means of the hidden curriculum Utopia y Praxis Latinoamericana 24(6) 387-95