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Introduction of Interactive Teaching Methods into the Disciplines of Forest Specialities: a Case of Petrozavodsk State University

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Abstract

At Petrozavodsk State University, within the academic process, an experiment with students was conducted involving higher interactivity of studying in a cycle of disciplines related to organization of forest exploitation. The following disciplines were taken as basis: "Design of timber industry enterprises", "Forest harvesting operations technology", "Technology of reforestation works", "Forest care", and for each of them, examples of organization of interactive methods of teaching the students in the direction of applied bachelor's degree "Technology of forest harvesting and timber-processing production". In order to increase the quality of education and the efficiency of implementing the interactive teaching methods, three directions were selected: development of academic process organization plans, creation of conditions for giving classes, and elaboration of new approaches to teaching taking into account the analysis of results of the experiment. The analysis of results has demonstrated that if interactive teaching methods are implemented in the academic process, the students' level of knowledge rises, skills and abilities for independent work are consolidated, the subject of work is better understood, and the interest for independent work, participation in conferences is manifested, as well as the abilities for generating new ideas and skills of defending them, and the process of self-determination within the profession selected are activated.

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Keywords: academic process; interactive teaching methods; forest harvesting enterprise; quality of education; higher education

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1. Introduction and literature analysis

The main task of a higher education institution in the modern society is aimed at ensuring high quality education having which a graduate using the obtained knowledge, abilities and skills would be able to quickly adapt to production processes of the occupation selected. In the system of classical higher education having established by nowadays, classroom studies based on passive teaching methods prevail. There are both numerous supporters and opponents of this form of teaching. To disadvantages of this kind of classes, lack of learners to teacher feedback, passive perception of somebody else's opinion, restricted impulse for independent work and thinking are referred, as well as some others (Michel, Carter & Varela, 2009; Albanese & Mitchel, 1993; Bonwell & Eison, 1991; Sirotkin, 2014). As history shows, giving lectures cannot be abandoned completely. In the 1930s, they stopped giving lectures at some higher education institution as an experiment; however, the experiment proved not justified due to a sharp decline of the students' level of knowledge (Sirotkin, 2014).

Currently, the notions that were put into the "classical lecture" are practically lost – the ones based on the emotional interaction of the lecturer with the audience, development of the students' active attention and their cognitive activity. The work of a lecturer started to consist in dictating the educational material with constant repetition for those failing to put down the voiced text in time. With ubiquitous multimedia teaching means, a lecture has turned into the mechanical copying of text from the presentation. Meanwhile, a student writing down the content of presentation slides does not perceive the oral information given by the lecturer and accompanying the slide, as a result of which the material presented is not adopted, because the student does not have time to consider and analyze the educational material. Such an approach leads to the student's forgetting the obtained by him strong theoretical knowledge by the end of studying, and there are no professionally significant practical skills that stay in memory for a longer time worked out in the due scope.

This is why lecture material shall contain what is first of all used in practice, and the educational process shall be designed so as to consolidate the practical skills, that is, to make studying more active and interactive. The first research of models of the listed teaching methods included the following provisions:

- active participation of students in the academic process and not the passive information perception by them;
- the opportunity of applied use of the knowledge in real conditions;
- representation of concepts and knowledge in most varied forms, not just in the text one;
- an approach to teaching as to a collective and not individual activity;
- focus on the process of studying and not on remembering the information (Kozma & Johnson, 1991; Constructing Knowledge Societies:New Challenges for Tertiary Education, 2002).

Taking into account the listed provisions, within the educational process, an experiment has been conducted of raising the interactivity of education with the students in a cycle of disciplines related to organization of forest exploitation.

2. Implementation of interactive teaching methods in the educational process

In order to improve the quality of education and efficiency of interactive methods implementation, three work directions were employed: creation of conditions for giving classes, working out of educational process organization plans, development of new approaches to teaching with the results of the experiment borne in mind.

For evaluating the efficiency of implementation of interactive teaching methods, the comparison of results of the students testing after lectures (passive learning) and after practical classes (interactive learning). A survey was also conducted among the students about the forms of giving classes. Annual testing takes place for three years (since 2012 up to 2014) for 3 year students of the direction of applied bachelor's degree "Technology of forest harvesting and timber-processing production". The total quantity of students participating in testing and survey was 44 people as of the paper publishing date.

The conditions of giving practical classes in the interactive form involve the use of modern education equipment such as simulators and going of the student group guided by the teacher out to production sites, also to ones of the leading industrial enterprises of the forest complex of the Republic of Karelia. In order to improve the quality of education, the following equipment was purchased for educational purposes: Ponsse training simulator of forest harvesting machines, Stihl-MS260 power saws, Stihl FS450K brush cutters, workwear suits (hard caps, jackets, trousers, boots, and gloves), Haglof calipers, Suunto PM-5/1520 height gauges, cross-wire meter, NikonForestryPro laser rangefinder; Suunto KB-14/360 surveyor's compasses, Stayer measuring tapes, marking tapes, increment borers, increment hammers, angle gauges, GarminOregon 650 T navigators, tree-planting tubes, baskets for transplants etc. The forest plots for interactive classes were selected on the basis of PetrSU technology park and forest harvesting enterprises (Shuyales, LesMA and others).

The university management allotted a 5 ha forest plot on which various natural and working conditions of the terrain are represented. For example, there are forests of various age groups, swampy areas, and key biotopes for maintaining the biological diversity. Elements of forest infrastructure used in forest harvesting production are also prepared: the earth bed of timber transport road (Figure 1), borders of cutting areas, tracks, loading site, timber stacks, selection cutting (Figure 1), results of work of various system machinery (harvester, forwarder, feller), defects of trees.

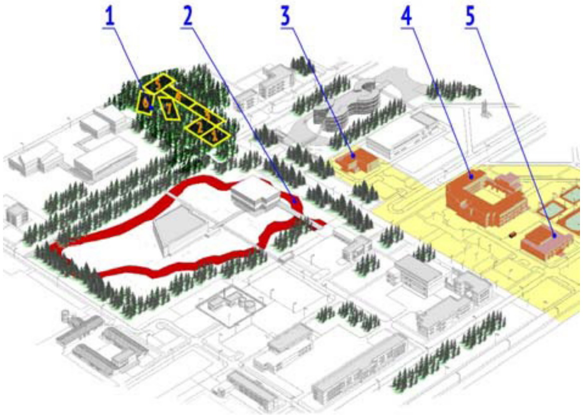

Figure 1. The area of PetrSU technology park (Albanese & Mitchel, 1993):
1 – sample plots of the project; 2 – scientific-research and educational complex of Smart Track project; 3 – the building of Onego university swimming pool; 4 – the building of the faculty of physics and technology; 5 – the building of the scientific and educational center

In addition, an agreement has been signed with the main timber industry enterprises of the Republic of Karelia about demonstrating the forest harvesting processes for the students in real time. Among them, the key player is Shuyales company which has closely cooperated with Petrozavodsk State University for many years and has been involved in the academic process directly. For example, Andrey Victorovich Pladov, the director of the enterprise, defended his thesis for the scientific degree of a candidate of technical sciences at PetrSU; he is on the State examination board as its chairman. Every year, the students go to field training at this enterprise, and the ones giving a good account of themselves during the study process get the opportunity of employment with the enterprise. Owing to such cooperation of Petrozavodsk State University with Shuyales, the leading enterprise of the timber industry complex in the Republic of Karelia, there is an opportunity to introduce students to all phases of both forest harvesting process and sawing production that is performed on the basis of Solomenskij Lesozavod JSC (Solomenskiy sawmill).

For organizing the educational process with introduction of elements of active and interactive teaching methods, plans and educational programs, methodical instructions for teachers and students were developed. The following disciplines included in the educational plan of students training in the direction "Technology of forest harvesting and timber-processing production" were selected as basis: "Design of timber industry enterprises", "Forest harvesting operations technology", "Technology of reforestation works", "Forest care". The listed disciplines cover almost all sides of forest harvesting process (Shegelman & Lukashevich, 2012), beginning with preparatory forest harvesting operations and exploitation of cuttings with their subsequent reforestation and care. Figure 2 outlines the following directions for enhancing the interactivity and approximation to the real production process: coupe demarcation and taxation, forest harvesting production, reforestation, care after further development of the growing stock.

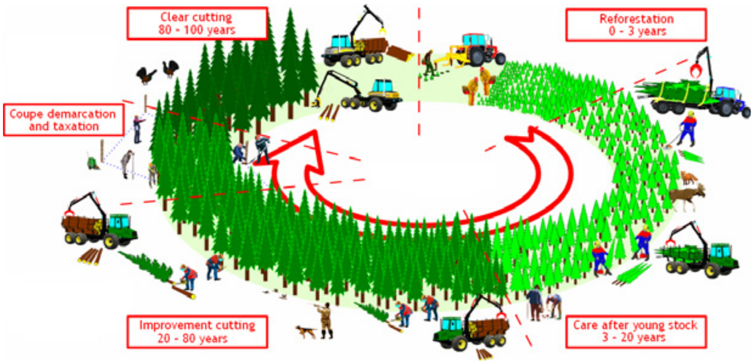

Figure 2. Directions for implementing the interactive teaching methods

Let us consider the techniques of interactive teaching methods in more detail at each phase.

The students familiarize themselves with the bases of coupe demarcation and taxation when studying the discipline "Design of timber industry enterprises". The objective of these measures consists in registering of borders of the future cutting on the terrain and obtaining qualitative and quantitative parameters of the growing stock in it (Shegelman & Lukashevich, 2012). The theoretical foundations of coupe demarcation and taxation are presented at lectures, and field practical classes are provided for consolidation of skills and abilities. The Institute of Forest, Engineering and Construction Sciences of PetrSU (IFECS PetrSU) has purchased the required modern taxation equipment for organizing the classes. A group of students is broken down into teams (3-4 people each), and certain forest plots with their terrain maps are assigned to the teams. On the first day, the students get trained in safety and learn the locations and borders of all objects required for terrain orientation. Within the area, special notice plates are installed containing the information about location of the field objects (Sjunev, Sokolov, Kilpeljajnen, Lukashevich, Pekkoev & Suhanov, 2014). Next, the teacher familiarizes the students with taxation equipment (measuring tape, caliper, surveyor's compass, height gauge, borer etc.), explains them the plan and sequence of performance of works, after which the students appoint the team leader among them and start measurements. The data are registered in special forms. The works are planned for 6-8 hours during two days. The field works consist of two parts. On the first day, the students restore the borders of cuttings, perform the complete enumeration of trees and evaluation of quality of the works performed. On the second day, similar works are performed on the sample area for evaluating the taxation characteristics of initial growing stock (Figure 3).

Figure 3. Consolidation of skills of coupe demarcation and taxation by the students

Having completed the field works, the students set to office study of the data collected. They determine the area of the plot, its species composition, reserve of the forest, the absolute normality (area of sections of the growing stock), scope of defects etc. both at the cutting and at the sample area. At the end of work each team draws up the materials of demarcation (sketch, enumeration record, material and money evaluation) required for organization of further technological process of forest harvesting production.

The machinery, equipment of forest harvesting and technology of their operation (Figure 2) are studied within the discipline "Forest harvesting operations technology". The interactive learning elements within this discipline are the developed by IFECS individual works on determining the capacity of various forest harvesting machinery and equipment (Patjakin et al., 2012; Shegelman, Skrypnik & Galaktionov, 2011). Based on the calculations, the ideas of students about the structure of the machines, their work techniques and opportunities of their operation in various natural and production conditions are consolidated. The university has also acquired a simulator (Figure 4a) for consolidating the work skills. The students learn and get the skills of operating forest harvesting machines (harvester and forwarder). A compulsory condition of learning is completing the educational and production practice at timber industry complex enterprises where the students familiarize themselves directly with the production processes. One of the forest harvesting production phases is construction of roads. Within the international project (Lukashevich et al., 2014), on the premises of PetrSU (Figure 1), the construction of a timber transport road was organized by forces of IFECS. As of now, the earth bed is constructed and surfacing construction works are in progress. The object will include various methods of earth bed construction and types of surfacing. It is also planned to organize traffic of timber transport vehicles on the road and to register its effect on the structure. The presence of such an object allows the students to see all road construction phases, to pay attention to soft spots and possible mistakes both at design phases and at construction ones (Figure 4b).

Figure 4.The students work with Ponsse simulator (a) and construction of timber transport road on PetrSU premises (b).

After forest harvesting, a compulsory phase of forest harvesting production is reforestation operations at the plot (Figure 2). The machinery, equipment and technology of reforestation operations are studied within the relevant discipline. The main objectives of training is the students' studying and familiarizing themselves with all phases of reforestation, from production of planting material to reforestation operations, survey of the existing machinery, equipment and technologies used both in Russia and abroad (Figure 5). Currently, it is planned to organize the educational process in such a way as to engage the students directly into forest planting, alongside with lectures and laboratory works. For this, tree-planting tubes have been purchased, and IFECS is negotiating with management of the enterprises on selecting the forest plots.

Figure 5. Familiarization with planting material production (a) and performance of reforestation operations (b)

After completion of reforestation operations, subsequent care of the cultures planted is essential (Figure 2). At present, the discipline "Forest care. Improvement cuttings" has been designed and implemented into the educational process. The objective of the course under consideration consists in development in the students of a comprehensive idea about the most important forest management measures aimed at formation of stable highly efficient and economically valuable timber stands, maintaining and enhancing their useful functions and timely use of the wood. Its tasks include introduction of forest care types, their modern condition and prospects to the students, the development of skills to prescribe the required forest management measures, evaluate the quality of improvement cuttings, as well as familiarization with technologies and equipment used in improvement cutting; getting to know the foundations of design and feasibility study of improvement cuttings, the programs of growth progress imitation, the foundations of safety, occupational safety and health at the forest harvesting production. The educational practice was conducted on the production site of Shuyales forest harvesting enterprise and the students' participation in improvement cuttings was organized. The personnel of the enterprise selected a forest plot where the students mastered the required skills of operating the power tools and learned the bases of care after the young stock (Figure 6).

Figure 6. Students' practice at improvement cuttings

In teaching, various specialized software is also used for consolidating of the knowledge obtained and for having the opportunity to check them. One of such specialized software products is MOTTI (Patjakin et al., 2012), the rights for using which in the educational process were handed in to IFECS within an international project (Lukashevich et al., 2014). MOTTI software product developed in METLA scientific and research institute of forest, Finland, allows prescribing various forest management measures and analyze growth progress of the growing stock meanwhile (Suhanov et al., 2012; MetINFO – MOTTI Stand Simulator, Introduction, 2015). The program enables the students to model taxation parameters of the growing stock, set type of soil and ground conditions, climatic parameters of the area, or upload the forest plot parameters already generated. Growing stock growth progress can be modeled in the "automatic" or "manual" mode. In the "automatic" mode, the program suggest to the user a plan of forest management measures according to recommendations of Tapio Forestry Development Center. In the "manual" mode, a student can prescribe various measures, including improvement cuttings, administration of fertilizers and melioration of forest plots having peat soils. The student can also set such parameters as care intensity, terms of improvement cuttings and clear cuttings. As a result of operation of the program, the summary graph of changing of the total of cross section areas of tree trunks in the growing stock is displayed with the additional information in main points of the graph. Detailed information about distribution of the wood obtained according to grades (saw timber, pulpwood, fuel wood, waste wood, deadwood) is available for the student. The distribution according to species, to runs of improvement cuttings can be viewed separately, as well as the one according to clear cutting. The program allows calculating the output of standing crop from the working plot for biofuel engineering, with the user being able to flexibly assign sources of biomass (e.g. fuel wood, forest harvesting waste). The use of imitation modeling of growing stock growth progress in the educational process of forest specialities allows the students to consolidate theoretical foundations of the growing stock development and its key taxation parameters, to select the types of forestry measures and set deadlines for their performance, to analyze and evaluate the results of their selection.

3. Results and discussion

Testing of 3 year students of the direction of applied bachelor's degree "Technology of forest harvesting and timber-processing production" is conducted annually for evaluating the efficiency of the interactive teaching elements implemented into the educational process as presented above. At the first lecture, the students are given a test proceeding from which the teacher evaluates the existing knowledge and competencies of the students obtained as a result of studying previous related disciplines, educational practice, independent work etc. The objective of testing also consists in finding out what topics were learned by the students worst of all, in timely correcting the educational process, and in focusing the attention on problem spots in knowledge and abilities of the students. After a course of lectures and classes using interactive teaching methods, the students are given a wider scope of questions. They are not warned about the day of testing. This allows evaluating the discipline mastery degree, including the remaining knowledge. Tests were conducted for three years (since 2012 up to 2014), and the total quantity of students having taken the test was 44 people as of the paper publishing date. Comparison of testing results has demonstrated that the percentage of correct answers is 35% higher after completing the practical classes presented in the paper. With regard to this, the topics considered at the same time at lectures, at practical classes in the forest and at independent works in classrooms are better remembered by the students and are of more interest for them.

In addition, for the same group of students learning, a questionnaire survey was conducted in order to study their attitude to laboratory classes using MOTTI software in the display class. The survey has shown that all students had taken the idea of consolidating the knowledge obtained during studying of the discipline using computer experiments on model growing stocks positively. Over 70% of the students considered the experience of working with MOTTI software useful for themselves. Operating the software did not cause any serious difficulties – as over 70% of the students pointed out, MOTTI software had an easy to understand interface. It is prescribing the forest care measures that is the most difficult for the students (50% of the surveyed) during the computer experiments.

An interesting fact can also be mentioned that implementation of interactive teaching methods allows conducting work with the students more closely, studying the object and means of work more profoundly, and therefore finding new interesting technical solutions for perfecting the existing processes, machinery and equipment of the forest harvesting production that require intellectual property rights protection. In the recent years, patent engineering has been reactivated at the university (see Table 1) and the relevant courses for the students have been developed.

Table 1. Dynamics of Petrozavodsk State University patents acquisition

Year	Total for the University	Of them at the chair of FCTO
2009	1	0
2010	8	4
2011	15	12
2012	24	16
2013	40	27

As a result, the quantity of patents over the recent 5 years has risen from 1 to 40 at the university, and slightly over 100 certificates of intellectual property rights protection have been obtained. Among them, the greater part was obtained by members of the chair of Forest complex technology and organization (FCTO) of IFECS where the interactive teaching methods are being implemented actively and there is close interaction with students. This is why the students have started to increasingly appear among the authors, because the students have obtained 12 useful model patents and have made 5 applications during the recent three years. In total, some 20 students have been engaged in the work, with 3 people among them succeeding in confirming the significance of their ideas in the contest "Participant of the science and innovation contest for the youth "U.M.N.I.K." conducted by the Federal state budget-funded institution "Foundation for promoting the development of smaller scale enterprises in the scientific and technical sphere". They have been awarded grants for bringing their ideas into life.

4. Conclusion

One of the problems of education institution graduates is the difficulty getting subsequent employment without work experience, especially for graduates of forestry profile technical specialities. In connection to this, formation of the students' academic process so as to enable them to get both high quality knowledge and practical skills is vital for higher education institutions having forestry education directions. A solution for this problem is implementing new methods of teaching.

The organization of work in the academic process at IFECS containing elements of passive, active and interactive teaching methods allows familiarizing with key topics of forest exploitation organization in more detail, including the entire chain of forest harvesting process from reforestation and forest care to coupe demarcation and taxation, its exploitation by various systems of machinery and equipment. This helps students in their further study during production practice and after graduation during their work according to the speciality. The use of imitation modeling in the academic process allows making more correct decisions of forest management and acquiring professional and generic competencies in the area under consideration. A close interaction of the academic process with forest harvesting production and focused cooperation with enterprises forms the future highly qualified professionals who can independently get involved into production processes and use the knowledge and skills obtained since their first days of work.

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