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УДК 004.4'24:378.091.214 (083.17)

ANALYSIS OF PROCESS CREATION OF THE COURSES TIMETABLING

Sakaliuk O.¹, Trishyn F.²

^{1,2}Odessa National Academy of Food Technologies, Odessa, Ukraine

ORCID: ¹<https://orcid.org/0000-0002-5051-518X>, ²<https://orcid.org/0000-0001-5994-3538>

E-mail: ¹sakaliuk.olexiy@gmail.com, ²fatrishyn@gmail.com

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DOI:

Анотація: Організація навчання здобувачів освіти, здійснюється відповідно до розкладу занять. Розклад занять має забезпечити ефективне виконання навчального плану в повному обсязі.

Питанням формування розкладу навчальних занять приділялася достатня увага протягом останніх десятиліть. Але навіть і сьогодні процес формування розкладу навчальних занять вимагає достатньо велику частину людського керування. Типова проблема розкладу занять полягає в плануванні набору зустрічей між викладачами і студентами протягом певного періоду часу, що потребує певних ресурсів і повинно відповідати деяким додатковим вимогам. Суттєвими вимогами при складанні розкладу є такі, в яких викладач, студент або аудиторія не використовуються більше одного разу в один часовий інтервал. Складання розкладу в закладах вищої освіти виконується кожен семестр. Підготовка розкладу є трудомістким, стомлюючим процесом, що вимагає значну кількість людських ресурсів та часу.



У даній науковій статті проводиться аналіз процесу формування розкладу навчальних занять. В ході роботи досліджуються основні керівні документи для формування розкладу навчальних занять. На основі контрольованого спостереження, де спостерігач був включений у процес та проводилося в реальних умовах, на базі диспетчерської навчального відділу Одеської національної академії харчових технологій описується процес формування розкладу навчальних занять та визначаються основні структури закладу вищої освіти, які при цьому задіяні. Відбувається розподіл обмежень, яких потрібно дотримуватись при виконанні процесу на жорсткі та м'які. Досліджуються актуальні рішення, такі як: генетичний алгоритм, жадібний алгоритм, метод розфарбовування графу, метод логічного програмування з обмеженнями тощо. Описується від чого залежить результативність роботи даних методів та алгоритмів.

Abstract: The organization of education for persons who are studying is carried out in accordance with the courses timetabling. Courses timetabling should provide an effective implementation of the curriculum in full.

The problem of creating the courses timetabling has been given sufficient attention during the last decades. But even today, the process of creating the courses timetabling requires a fairly large part of human control. The typical problem of creating the courses timetabling is to plan a set of meetings between teachers and students over a period of time that requires some resources and should meet some additional requirements. Significant requirements in scheduling are those in which the teacher, student, or audience is not used more than once at the one-time interval. Creating the courses timetabling in institutions of higher education is carried out every semester. Preparing the timetabling of the courses is a labor-intensive, tedious process that requires a significant amount of human resources and time.

In this scientific article, an analysis of process creation of the courses timetabling is carried out. In the course of work are investigated basic guidance documents for the creation of the courses timetabling. On the basis of controlled observation, where the observer was included in the process and conducted in real conditions, on the basis of the dispatch of educational department of the Odessa National Academy of Food Technologies, the process of creation of the courses timetabling is described, and the main structures of the institution of higher education, which are involved, are determined. On the basis of controlled observation, where the observer was included in the process and conducted in real conditions, on the basis of the dispatch section of educational department of the Odessa National Academy of Food Technologies, the process of creation of the courses timetabling is described, and the main structures of the institution of higher education, which are involved, are determined. Constraints which must be observed during the process are divided into hard and soft. Actual solutions are investigated, such as: genetic algorithm, greedy algorithm, graph coloring method, method of logical programming with constraints, etc. Describes what determines the performance of these methods and algorithms.

Ключові слова: розклад занять, освітній процес, планування, заклад вищої освіти, формування розкладу

Keywords: timetable, educational process, planning, establishment of higher education, scheduling

1. Introduction

The basis of the qualitative organization of the educational process of any educational institution, especially the institution of higher education is a schedule of the courses. The quality of the training of specialists depends to a large extent on the methodically correct established schedule of the courses. The schedule of the courses and examinations is one of the most responsive, time-consuming and tedious tasks of planning the educational process. Schedule of the courses is the main final document of planning, which regulates the educational work of students, participants in the educational process (teachers) and the engineering and technical staff of the institution of higher education [1].

2. Analysis of literary data and problem statement

The organization of the educational process is based on the Laws of Ukraine "On Education", "On Higher Education", "On Scientific and Scientific-Technical Activity", normative legal acts of the Verkhovna Rada of Ukraine, the Cabinet of Ministers of Ukraine, the Ministry of Education and Science, the National Quality Assurance Agency higher education, standards of educational activity and standards of higher education and other normative documents.

The problem of creation of the courses timetabling is an integral part of the work of any educational institution, including the institution of higher education. There are many works that focus on solving the problem of educational planning [2-17]. However, most of their work is outdated, or they are incomplete overviews of the task of creating an effective schedule of training sessions and automation of scheduling, they address only certain aspects of the problem.

In any organization, there is always a problem of efficient data management. Higher education institutions are no exception. From the point of view of formalization in the scheduling theory, the schedule of classes is a definition on the time scale of the place where the discipline is conducted and the fulfillment of the requirements specified therein. To develop an effective automation control system of the process creation of the courses timetabling, it is necessary to determine all requirements and relationships between them. У зв'язку з цим, актуальним є аналіз процесу формування розкладу навчальних занять. In this regard, the analysis of the process creation of the courses timetabling is relevant.

3. Purpose and objectives of the study

The main purpose of the study is the analysis of process creation of the courses timetabling as a control object. It's must accomplish the following tasks to achieving the goal:

- to explore the main guidance documents for the creation of the courses timetabling;



- to describe the process of creation of the courses timetabling;
- to identify the main factors that affect schedule;
- to investigate actual solutions, algorithms and methods of creation of the courses timetabling.

4. Methods and materials of research

Realization of the research of the process was conducted on the basis of the dispatch of the educational department of the Odessa National Academy of Food Technologies.

Creation of the courses timetabling was conducted using the information system "Rozklad" (<https://www.rozklad.onaft.edu.ua/>), using the following information: information of the departments of the Odessa National Academy of Food Technologies with the fixation of the discipline by the corresponding teacher and recommendations on the audience; working curricula; information about student groups.

The main method of this study was observation, where the observer was included in the process creation of the courses timetabling as a participant. Observation is controlled by degree of formalization and conducted in real conditions. Regularity is not systematic namely participants in the process (researcher and staff) deal with unplanned phenomena and unexpected situations.

5. Research results

The study of the organization of the educational process, from the Law of Ukraine "On Higher Education", makes it clear that the creation of the courses timetabling requires compliance with certain conditions, in particular, the right choice of the audience, in accordance which it is necessary to choose a participant in the educational process. Relevant audiences are intended for each type of courses, as well, the number of students should not exceed the maximum permissible amount corresponding to the type of course.

Creation of the courses timetabling can be divided into the creation of the courses timetabling for students with a full-time forms of education, the creation of the courses timetabling for students with part-time training and the creation of the schedule of examinations, credits, retraining, counseling, additional types of workload, such as distance learning, etc.

The following structures of the institution of higher education are involved in the creation of the courses timetabling:

- deputy head of the institution of higher education (Vice-Rector for Scientific and Pedagogical and Educational Work);
- the educational department (head of the educational department, dispatch of educational department);
- deans of faculties;
- departments and heads of corresponding departments.

Deans of higher education faculties prepare plans, which are transmitted to the educational department. Schedule of the educational process is made on the basis of these plans. Schedule of the educational process agrees with the dean of the corresponding faculty and signed by the head of the educational department and by the vice-rector, after which it is approved by the Academic Council and signed by the head of the Academic Council. The dean's office then submits a curriculum schedule to the department, signed by the dean, created on the basis of the working curriculum and the schedule of the educational process. Departments receive the amount of educational work from the educational department and fix the teachers' corresponding teaching load in accordance with the legislative acts and staff units assigned to the planning and finance department. When planning the work of the teacher, the conditions are taken into account, in which the duration of the teacher's work per week does not exceed 36 hours, if the teacher works at one rate. Therefore, if the teacher works one and a half times the rate, the indicator in 36 hours grows in 1,5 times. This assertion of disciplines for a teacher the departments give to the educational department for drawing up a schedule. The educational department gives a schedule of the educational process. The plan-schedule of the dean's office should be correlated with the schedule of the educational process. The project of the schedule is agreed with a dean, after the process creation of the courses timetabling is completed. After the agreement with the dean, the schedule is approved by the vice-rector and by the rector.

Departments provide conformity of disciplines to teachers to the educational department. Dispatching department, which belongs to the educational department, based on this distribution and according to the work plans, compiles a schedule of courses. The main problems that can be encountered when creating the schedule of courses are the limited volume of the auditorium, the employment of teachers at other positions in the institution of higher education and other institutions, the regulatory legal framework regulating the number of class hours per week, etc.

Educational disciplines can be cancelled only in exceptional cases and only on a special instruction of the head or deputy head. Reasons for cancellation must be legally stipulated.

Fully prepared by a specialist of the faculty forms with the schedule of courses are transmitted to the Dean's approval. The consent is made within one day, during this period the necessary changes and additions proposed by the dean of the faculty are discussed, accepted and entered into the schedule. Then the agreement is made with the heads of the departments. As a result, the deputy head of the institution of higher education agrees to the schedule.

For the purpose of organizing the examination session with students, a special timetable is created annually for the period of final exams control. The following conditions must be fulfilled: the duration of the ex-post exams control should coincide with the terms that were approved in the curriculum schedule; at least 3 days should be allocated for preparation for the exam. The schedule of courses, taking into account the comments and additions of the deans, agrees with the head of the educational



department and agrees with the deputy head of the institution of higher education. The current control of the schedule of courses is carried out by the staff of the faculty dean's office.

The schedule itself depends on many factors. They can be divided into objective (hard) and subjective (soft) parameters. The objective is a database of the university, which stores information about the audiences and subjects. Subjective is the wishes of students and teachers and recommendations for choosing an audience [2].

The following restrictions apply to hard parameters [3]:

- one teacher can teach no more than one lesson at a time;
- in one audience, no more than one сшгкы can be held at a time;
- in one group at a time not more than one lesson can be taught;
- the number of students in the audience should be no greater than the capacity of the audience.

The following limitations can be attributed to soft parameters [4-6]:

- absence of "windows" (this is a term used by the supervisors of the educational department, which means a free time interval between classes is longer than a break) for student groups;
- the number of courses conducted for groups should not exceed the given amount;
- the audience should correspond to the course type;
- limits of training hours per day (up to 6-8);
- it is desirable to hold lectures on the first and second pairs;
- the number of lectures should not be greater than 2 per day;
- separate wishes of teachers;
- it is desirable to concentrate classes for each teacher on separate days;
- minimizing the transition between faculty and students.

The literature presents the following methods for solving the problem of creation of the courses timetabling in higher education institutions:

Genetic Algorithm. In the genetic algorithm, each individual (set of chromosomes) is one of the possible solutions to the problem of the courses timetabling, that is, the variant of the schedule. There are several methods for selecting chromosomes that are based on one or another approach to chromosome fitness to the crossover. This fitness is determined using the target function. The genetic algorithm for solving the problem of creation of the courses timetabling is considered in the papers [7, 8].

Greedy Algorithm. An important role is played by greedy algorithms (sometimes it's called the principle of greed). This principle is to choose, at each step, from all possible alternatives the one that provides the least value of the criterion. This principle can be applied both when finding the initial timetabling, and at the stage of its further improvement [9].

Graph Coloring Method. To set the problem of timetabling a graph is constructed: each vertex represents a course scheduled by the curriculum; further, if there is a conflict between the classes, then they are joined by the edge [10].

Method of Logical Programming with Constraints. Timetabling of courses can be presented as a task of satisfying constraints. Programming with constraints is closely related to traditional logic programming, within which it was formed. Papers using the method presented in [11-14].

TABU-search. TABU-search is a meta-heuristic algorithm that conducts a local search to prevent it from being trapped in premature local optimums, by forbidding those displacements that make returning to previous decisions and cyclical work. TABU-search begins with the original solution. Each iteration generates a neighbourhood of solutions, and the best of this neighbourhood is chosen as a new solution. Certain attributes of previous decisions are stored in the TABU-list, which is updated at the end of each iteration. Choosing the best solution in the neighbourhood occurs in such a way that it does not accept any of the forbidden attributes. The best solution is currently being updated, if the new current solution is better and feasible. The procedure continues until any of the two stopping criteria is met, which is the maximum number of iterations performed and the maximum number of iterations, during which the current decision is not improved [15-17].

6. The discussion of the results

Subjects have several forms of the lesson. To classical it is necessary to include lectures, practices, laboratories, seminars, independent classes, exams, electives. Each teacher has his position, scientific rank and degree, which directly correspond to their importance and achievements at the department. Of course, the higher the position, the more important are the requirements of this teacher. Each teacher has his own schedule requirements and the priorities of these requirements, so they should all be taken into account. It should also be noted that not all forms of training can be conducted by all teachers. Lectures can be conducted only by lecturer's associate professors, practitioners and laboratories can be pursued by postgraduate students or lower than the rank of a person.

Algorithms of all these methods are approximate. The above methods are mainly theoretical. The effectiveness of the methods depends on:

- the volume and content a load of schedule;
- the scale of the auditorium fund;
- the volume of the teaching staff;
- schemes of the functioning of the educational institution;
- the number of proposed requirements.



7. Conclusions

In the document analyzed the process creation of the courses timetabling.

Initially, an analysis of the main guidance documents for the creation of the courses timetabling was conducted, namely, the Laws of Ukraine "On Education", "On Higher Education", "On Scientific and Scientific and Technical Activities".

A description of the process of creation of the courses timetabling was conducted and describes its main stages and the involved structures of the institution of higher education on the basis of the dispatch of educational department of the Odessa National Academy of Food Technologies. The basic conditions which must be observed in the creation of the courses timetabling and the factors influencing the process are determined. After that, the basic methods of solving the task of creation of the courses timetabling were studied. The results will be used for further identification of the control object.

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