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EXPANDING THE FUNCTIONALITY OF LEARNING MANAGEMENT SYSTEMS AND ANALYSIS OF THE IMPLEMENTATION RESULTS

Важливою функцією впровадження електронних систем навчання та управління навчанням є управління часом, або складання розкладу. Ця функція незаслужено оминається увагою більшості систем такого класу (LMS – Learning Management System), попри її затребуваність. Особливо це стосується систем класичного, очного навчання у класах. Отже, об'єктом дослідження є системи управління навчанням, тобто автоматизація функцій керування навчальним процесом. Однією з задач процесу планування навчання є складання розкладів. Саме цій задачі і присвячено дану роботу.

У роботі розглянуто один з варіантів розв'язання цієї задачі – запропоновано застосування адаптованого підходу до складання графіків роботи зі сфери масового обслуговування до проблеми планування роботи навчального закладу та складання розкладу занять для забезпечення потреб навчального процесу. Порівняно з іншими відомими методами, які є переважно «переборного» типу, даний метод є менш затратним і показує гарні результати у практичному застосуванні. Тобто, складені розклади є підходящими та вимагають мало додаткових людських затрат.

Отримано та продемонстровано позитивні результати впровадження розробленого програмного продукту на конкретних прикладах: підвищення якості роботи керівного складу, методистів та викладачів. Отримувані розклади виявляються якісними – такими, що відповідають або перевищують очікування. Це пов'язано зі схожістю підходів до планування, застосованих для розв'язку задач у обох галузях – управління персоналом кол-центру та складання розкладу для школи чи університету. Підвищено ефективність управління графіком навчання – зокрема, показники процесу внесення змін до розкладу занять.

Новизна та основна цінність роботи полягає у перенесенні та адаптації відомих методів до розв'язання нових задач. Таким чином вдалось розв'язати відому задачу новим адаптованим та прилаштованим під нові потреби методом. Більш того, даний метод є достатньо ефективним з точки зору часових витрат.

Ключові слова: *складання розкладу, система управління навчальним процесом, управління змінами, локальна оптимізація, мінімізація максимумів.*

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1. Introduction

Today, there is a constant increase in the supply and demand for distance and independent education, which are fueled by the all-pervasive concept of Life-Long Learning. The possibilities of distance learning systems have grown and provide the opportunity to organize courses, seminars (webinars) and other events. Their combinations in the form of entire training programs or nano-degrees, which have also recently gained significant popularity, also become a reality. So, Coursera, EdX, Moodle, Prometheus and many others realize not only the opportunities for learning in the classical remote mode (or rethought, given the capabilities of modern information technologies). They also provide a platform for organizing your own courses and training programs for various needs.

There is a wide range of systems and tools for implementing e-Learning and the concepts mentioned above [1, 2]. One of the most popular was and still is Moodle [3, 4]. Of course, such systems have a wide range of problems – from support with the complexity of using, adapting, and the convenience of automating the learning process and managing it [5, 6]. At the same time, off-line classical classroom instruction also has a number of advantages: it is motivation (the «race» factor), attention span, and a discussion style of teaching. Therefore, e-learning systems often try not only to «replace» the classics, but rather to complement and expand the methods of delivering information [7, 8]. An important feature of the latest systems is adaptability, taking into account the new methods and technologies available now: video communication, video lectures, the possibility of collaboration on one document, and much more [9–11].

Therefore, eLearning should rather be considered not as a competitor technology, but as a complement (a kind of reality supplement through the prism of the latest technological discoveries and opportunities).

At the same time, a number of functions are presented in LMS (Learning Management System) rather weakly. The reasons may be different, but such basic functions for teaching in classes, such as a schedule, are often limited only

by its representation (as a static «picture», that is, a «slice»). There is no possibility of assembling it within the system, as well as, accordingly, its further management – in particular, by making changes – that is, full editing. So, perhaps this is not a key function of LMS – though, first of all, such systems are focused on the nature and content of education – filling courses and ways to control the assimilation of material. As the development of this is personalized learning, it is more difficult to implement in the case of learning in classes, at the same time for many students with one teacher. However, this rather important function [12, 13] would be very desirable for representatives of the «classical» form of education. After all, it could significantly reduce the time spent on inappropriate activities, allowing more effort to concentrate on the «core business», that is, teaching and preparing quality course content. This work is devoted to overcoming this urgent problem. The development containing scheduling as a component of the learning process management system is presented.

So, *the object of research* is the learning management system, that is, the automation of the educational process management functions. One of the objectives of the learning planning process is scheduling. This work is dedicated to this objective.

The aim of research is to implement the functions of scheduling and managing its changes in the future in LMS. The schedule should be based on a number of parameters below, effectively in terms of the cost of computer and human time.

2. Methods of research

For schools and universities, the class schedule is one of the important documents that guides the learning process. At the input there are:

– load requirements of each teacher – how many hours, he/she will conduct classes per week;

– wishes on what days and times employees prefer to conduct classes (or what days are generally impossible for them through another type of employment);

– audiences of various types for each type of activity;

– other restrictions: classes can be sequential, which should go first, next and last, the limit of lectures per day, and the like.

It is also necessary to take into account the possibility of the following «change management», that is, the means for making changes: replacements, reschedules – both at a time and on a regular basis.

All these functions are characteristic of the contact center personnel management system (WFM – Workforce Management). So, let's take as a basis the approach to drawing up such a schedule of workers, and adapt it to the needs of the school (or university). It is not obvious that these two tasks are similar. But in fact, the elements (components) in both types of systems are quite similar (Table 1).

The basis of the developed method is taken from [14–16]. The idea of scheduling is to maximize the probability of covering the most significant need for each step of the algorithm. The algorithm is iterative, at every step it tries to reduce the level of needs by smoothing the peaks (minimize maxima). After compiling the reference schedule, the next step is the localization of optimization – the substitution initiated by the disturbance. That is, the algorithm tries to make local movements (in the classroom space – time – classrooms – teachers) in order to possibly optimize the overall coverage of needs. Such iterations of – «mprovement» are performed until a result is achieved that does not improve over the next few iterations, that is, which turns out to be stably stable (although probably locally optimal) [14–16]. The effectiveness of the method under various conditions is also subsequently verified in [17, 18].

Table 1

Correspondence of elements of two types of scheduling systems

WFM Schedule	School Schedule
Loads (need for man-hours in time)	Loads (amount of time in subjects and distribution in time)
Wishes (operator availability)	Wishes (business days and hours)
Locations (sites, remote contact centers)	Audiences (with different specifications, for different subjects)
TASK groups (solve common problems)	Teacher groups (that read some subjects)
Working hours (full-time, part-time, etc.)	Working hours (full-time, part-time, etc.)
Maximum limits (number of lines)	Maximum restrictions (audiences)
Relationships of activities (patterns, breaks, sequence of activities)	Restrictions on the sequence of classes and timing (if necessary)
Shift schedule (result)	Class schedule (result)

3. Research results and discussion

As a result, a scheduling module and LMS are developed (functionally oriented for the needs of customer schools of this product). The module for scheduling and subsequent changes is separable and universal in this sense, although it will require integration work to be implemented in another LMS.

So, Fig. 1, 2 presents the interfaces of a system that has been developed and implemented in several educational institutions.

According to the results of implementation, as well as test and industrial operation, a survey is conducted among users of the schedule subsystem (administration of educational institutions, teachers and teachers, methodologists – only 62 representatives, see the methodology in [19–21]), which shows:

– the level of satisfaction with the schedule among teachers is 85 % (before implementation – 72 %);

– the convenience of the schedule system is positively rated by 95 % (compared to the Excel/Doc/Web HTML options that were previously 63 %);

– flexibility of the schedule and ease of introduction of changes is appreciated by 80 % (before implementation, 45 % thought it was easy);

– the time cost is estimated at 16 hours per year (for a simple case) – compared with less than 80 hours (before implementation), thus, the savings amounted to 80 % of the time.

These results are more than acceptable for this task, therefore, the author believes that the initial task has been completed and the goal has been achieved. The developed software product – LMS with schedule functions – is recommended for implementation and use in teaching and learning practice to automate the conduct and management of the educational process in secondary schools and vocational, as well as higher, university, education.

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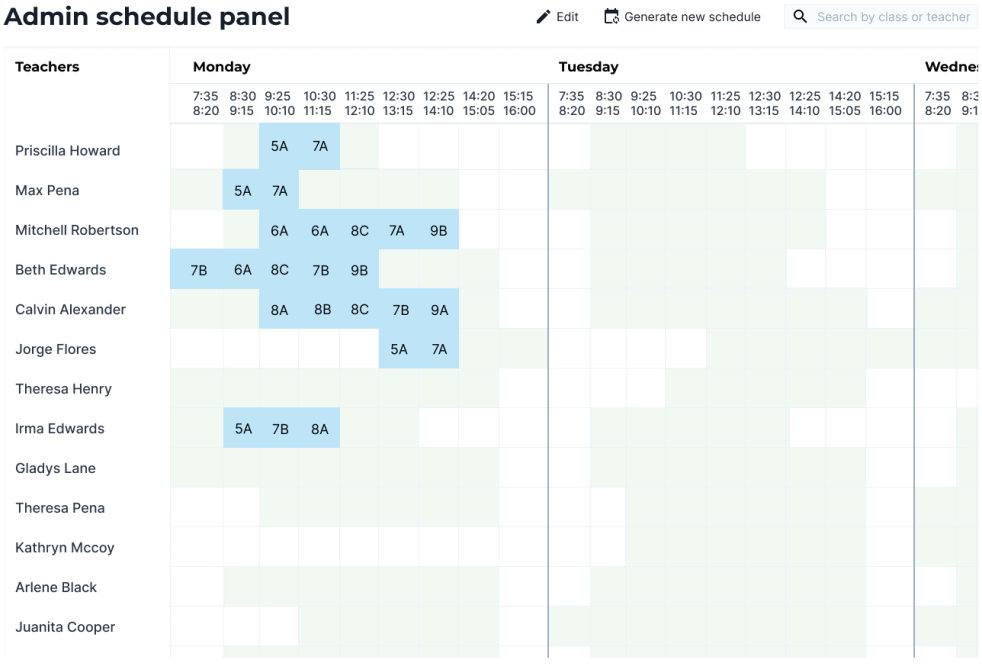

Fig. 1. An example of scheduling in the system

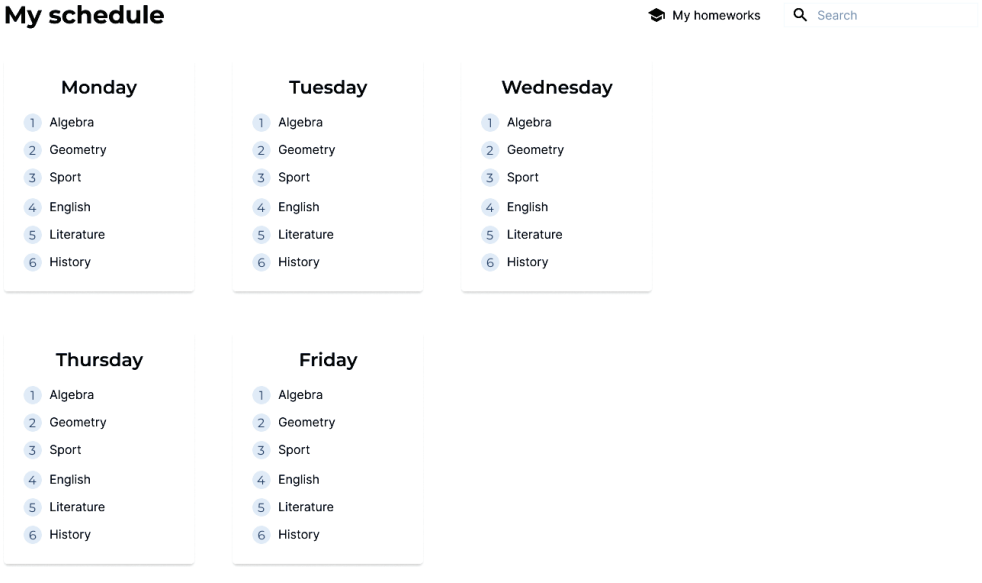

Fig. 2. An example of viewing the schedule by audience in the system

4. Conclusions

In the course of the work, the planning principles and scheduling algorithms in WFM systems are adapted to scheduling for the educational process and integrated into the LMS system. This makes it possible to effectively solve the problem of scheduling, which is important for educational institutions, at a new effective level. The quality of the compiled schedule and its flexibility, as well as the effectiveness of managing the training schedule, in particular, making changes to it, are improved.

The novelty of the work lies in the application of the adapted method for scheduling in a new, different, task, which makes it possible to solve the problem indicated at the beginning quite effectively. The research results and the product developed will be interesting for educational institutions at various levels, and are recommended for implementation in the planning and management work processes.

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