Systematicity of students' independent work in the course of operating systems

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Abstract. The paper is devoted to the study of systematicity of students' learning activity as a parameter of student's model, and influence of systematicity at learning results in the course "Operating Systems". The necessity to equip the student himself as the subject of the educational process with the skills and appropriate pedagogical forecasting tools for independent choice of the appropriate variant of educational activity is shown as theoretical framework. Parameters of models in such pedagogical diagnostics system are suggested and discussed. Empirical work has been realised on the base of learning management system *Moodle* and give possibility to analyse correlation between timeliness of completing the learning tasks by students and their educational achievements as well as to analyse the structure of students' time planning at homework. Recommendations to improve the educational process have been suggested

1 Introduction

1.1 Statement of the problem

Nowadays, effective educational process is not possible without active use of information and communication technologies. New educational environment puts forward advanced requirements to management of students' learning activity that become more independent. Such management should be grounded on comprehensive models. Theoretical basis of modelling of the open education organizational systems, theory of designing such systems have been expounded from systemic positions in monograph of V. Yu. Bykov [1]. A. E. Kiv, V. N. Soloviev, S. O. Semerikov [2] underline that Information technologies, especially, cloud technologies transform education, and have analysed according to results of the "Cloud Technology in Education" scientific conference modern approaches to managing students' learning activity in university educational environment. O. O. Triakina, O. O. Pavlenko, N. P. Volkova, and D. A. Kassim [3] have described the existing E-learning instruments that was designed by the international organizations for self-education and have suggested the ways of this tools implementation into professional training. K. Vlasenko, O. Chumak, I. Sitak, I. Lovianova, O. Kondratyeva [4] on the base of survey, conducted for teachers, suggested to develop an educational platform – an online environment for collaboration of the experienced professionals, whose joint activities should help in greatly enhancing their professional skills.

Independent work of students become one of the most significant part of modern educational systems. It is the demand of the curriculums and necessity to provide of the dual learning. Therefore, elements of distance learning are widely used in educational process as a form of education and as a form of management of students' independent work. Students' work is realised in specialised learning management environments without teacher's personal presence, and the teacher has no possibility to use traditional forms of pedagogical observation. The teacher needs in special system for management of students' independent learning activity instead of traditional intuitive management of learning process.

Learning management systems, for example *Moodle*, give us various new highly informative tools for pedagogical diagnostics. Management of students' learning activity in information and communication environment should be based on individual pedagogical prognosis for each student with use of an idealised student's achievements model, a model of student's real state and a model of available variants of learning methods [5]. The relationship between parameters of this models and indicators that can be directly measured in a learning management system should be studied experimentally and theoretically.

The field of interest in this paper is systematicity of student learning activity as a characteristic of student's leaning style and a parameter of student model in learning management system. Indicators of systematicity and its influence on student learning achievements are in the centre of our attention.

1.2 Analysis of previous researches

There are many scientific work devoted to students' independent work, its systematicity. But we want to pay attention to experimental data according to this problem.

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In focus of interest are time planning and influence of systematicity of students' learning activity on educational achievements. So, A. B. Valynuk, S. O. Konovalenko [6] pointed on the basis of survey that only 14% of students prepare to classes systematically, 8% – occasionally, but 78% of students work at home only before practical and seminar classes. L. V. Klimenko [7] believes that systematic learning work of students promotes accumulation of knowledge, mastering in skills. But large amount of short structured task leads to obliviousness of educational material, so special work for systematisation should be suggested to students periodically. O. O. Lavrentieva, L. M. Rybalko, O. O. Tsys, and A. D. Uchitel [8] draw attention to the necessity of planning independent work with accounting the complexity of its various types and analysing new methods of organization of students' independent study activities together with the use of ICT and tools. O. H. Kolgatin, L. S. Kolgatina, N. S. Ponomareva, and E. O. Shmeltser [9] have analysed the results of survey and concluded that the most common problems in systematicity of learning activity during the independent work of the students are the lack of instructions, the lack of cognitive interest, students' mistakes in self-management of own learning activity, teachers' mistakes in time planning for the systems of learning tasks for students' independent work. There were suggested some requirements for management of students' independent work for fixing these problems.

1.3 Objectives

Despite a number of theoretical and empirical studies in the field of modelling the learning process, there is no integrated model yet. Available models are based on teacher intuition and personal pedagogical observation that complicates using such models for pedagogical prognosis at managing the learning activity in Internet-oriented environments. Great work for specification of models parameters and its indicators, detection of pedagogical criteria influence at efficiency of educational process is very actual. In this way the **aim** of this paper is to study systematicity of students' learning activity as a parameter of student's model, to study influence of systematicity at learning result in course "Operating systems".

2 Theoretical framework

In the context of mass education, the teacher cannot pay enough attention to each student to make pedagogical forecast for each student on the basis of own intuition, experience, theoretical and methodological knowledge. It is necessary to equip the student himself as the subject of the educational process with the skills and appropriate pedagogical forecasting tools for an independent choice of the appropriate variant of educational activity. The teacher should manage this pedagogical diagnostics system and provide the student with necessary help. Design of the computer-based pedagogical diagnostic system requires the development of a learning objectives model, a student psychological and pedagogical model (SPPM) and learning technologies model that would form the basis of this system. These models should be specially structured and should contain a limited number of parameters, which can be directly measured in the educational process.

Let fix our attention at one of this three major models in the system of pedagogical diagnostics – the psychological and pedagogical model of the student (SPPM) [5]. SPPM is built on the basis learning objectives model so that the parameters of the student model reflect the forthcoming to the intended learning goal. The SPPM is to allow comparison of successive academic achievements, reflecting the dynamics of learning process. That is, this model should be dynamic. Based on the analysis of pedagogical science data in the field of educational achievement modelling [10-14], a system of criteria has been proposed [5] according to such components: motivation and target, educational content mastering, self-management and activity, reflexion and prognosis (see Table 1). Further comprehensive developing of this model needs in a lot of experimental data on correspondence between criteria indicators that can be directly measured in educational process and real results of students' educational work. But we have not enough such data in modern publications as it was shown in 1.2.

Table 1. Structure of the student psychological and pedagogical model.

Component	Criteria
Motivation and target	Significance of the result of educational activity for the student
	Student's interest in the educational process, cognitive interest
	Conscious adherence to the educational discipline
Educational content mastering	Completeness of knowledge
	Promptness of knowledge
	Depth of knowledge
	Flexibility of knowledge
	Systematic of knowledge
	Lasting of knowledge
	Automation of activity
Self-management and activity	Stability of pace of educational work
	Ability of the student to mobilize energy, persistence and will
Reflexion and prognosis	Student's reflection on the result of activity
	Student's reflection on the process of activity

Estimation of the parameters that characterise the educational content criteria is carried out by means of pedagogical testing based on the concept of the level of educational achievements in accordance with the works of V. P. Bespalko [11] and I. Ya. Lerner [12] as well the Ukrainian educational standards. These works are not modern, but classic. The ideas of V. P. Bespalko correlate with B. Bloom's taxonomy [15], but V. P. Bespalko's approach is more simple and useful for practical automated pedagogical measurements. I. Ya. Lerner's ideas give us possibility to classify criteria according to indicators than can be measured directly as it was shown in [5].

The parameter of the lasting of knowledge has not included to composition of database for model

parameters [5]. According to definition, lasting of knowledge is the permanent fixation in the student's memory of the system of essential knowledge and methods of their application or the willingness to derive the necessary knowledge from other based knowledge [12, p. 22]. A natural measure of lasting of knowledge is the ratio of the appropriate mastering coefficients according to the preliminary and current testing. If the mathematical model used in the automated system of diagnostics considers the parameters of student's academic achievements in dynamics (as a function of time), then a separate parameter "lasting of knowledge" is not needed. It is replaced by the functional dependence of all other parameters on the time that, definitely, carries more information.

The parameters of the student's psychological and pedagogical characteristics are determined by the teacher on the basis of pedagogical observation and analysis of the products of the student's educational activity. The student also takes active part in determining these parameters by introspection.

A high level of reflection on the result of the activity indicate the student's ability to objectively evaluate own results of the learning activity and his desire to complete the task qualitatively, to bring the work to a logical conclusion. The presence of an appropriate parameter in the student psychological and pedagogical model (SPPM) gives a reason to offer students, who have the developed reflection to the result of own activity, educational tasks of a creative nature. Otherwise, such tasks as projects, creative works etc. can be ineffective without student's own reflection, because it is difficult to build an objective and unambiguous algorithm for its checking.

High importance of the result of learning activity for the student is expressed in the desire to master given knowledge and skills as soon as possible, to get the result of the activity in the form of a fully completed task or project, a solved problem, etc. Of great importance is the student's sense of satisfaction from the successful completion of similar tasks in the past [13]. The organization of education of such students should provide for certain stop points at which the student can feel the completion of the stage of work. It is advisable to prevent the unexpected additional tasks and complications.

High interest in the process of learning is often native for students with research abilities, who can unlimited improve a computer program or laboratory equipment, collect some data from the Internet and so on. Modern multimedia tools and intelligent learning systems help to increase delight of the learning process itself. But the interest in certain activities in the absence of significance of the learning result leads to a shift in the focus on minor things and reduce the effectiveness of learning. Such students need in regular diagnose of the structure of academic achievement and control the implementation of the curriculum. They need in systematicity of learning activity according to curriculum. Such systematicity can be achieved by direct management of student's independent work or by training the student in skills of self-management. Cognitive interest as a separate parameter of the student model provides an opportunity to distinguish features of the student's motivation for learning activities. An important element of the emotional setting for learning activities is the conscious adherence to the educational discipline [14], which is expressed in the self-control of the correspondence of the learning activity to the work plan and culture of interaction with other participants of the educational process (timely completion of tasks, conscious fulfilment of requirements, accuracy in visiting classes and appointed consultations).

The strength and stability of the student's concentration on learning activities in a particular discipline largely depends on the peculiarities of the mental processes and physiological properties of the student and determines the style of educational activity. Therefore, it is important to add to the student model (SPPM) a parameter that characterizes a student's ability to mobilize persistence and will [13], and a parameter that characterizes the stability of the pace of student's academic work [14].

Activity of the student on introspection, observation of student's educational work, analysis of the style of educational achievements tests passing, analysis of the order of performance and presentation of educational products, analysis of the content of products of educational activity - are the sources of the information for the SPPM. It is advisable to measure parameters of reflection, emotional setting and volitional qualities on a scale of order (low, medium, high). The application of the equal-interval scale is problematic, because these parameters are complex and may include various indicators with significantly non-linear effect. Such measuring becomes a problem in case of lack of personal interconnection between student and teacher.

Summarising the above, it should be pointed that systematicity of learning activity is a complex indicator, which is connected with student's motivation, competency in self-managing, ability to stable work. But this indicator can be directly analysed in Internet-oriented learning management systems, such as Moodle. In this paper the systematicity of student's activity will be understood in context of activity by the plan given by teacher or designed by student in accordance to curriculum.

3 Methodology of empirical research

Study of features of students learning activity, connection between its systematicity and students' learning achievements was conducted in course "Operating Systems" with use of learning management system *Moodle*. Methods of learning the course "Operating Systems" are not a matter of this paper, but we should to describe the ground of our empirical work. This course combines theoretical and practical issues of operating systems concepts, models of its interconnection with hardware, applied software and users [16-18]. The first content module of this course is devoted to history and diversity of operating systems according to peculiarities its application. Students should understand the basic principles of computer hardware building, in particular, John von Neumann principles,

shared bus architecture, address space, function of the registers, interrupts etc. One of the main fundamental issues of this module is to show the deep connection between the hardware and operating systems architecture. The simple operations in operating systems with use of command interpreter and graphical user interface were also the object of students' educational activity. Second module is devoted to detailed study of main abstractions in the theory of the operating systems: virtual memory, processes and threads. Students used built in and third party software as well as the authors' models to investigate the peculiarities of internal mechanisms of multiprogramming realisation, especially of scheduling CPU time and access to slow devices as well as RAM memory access. The third module covers wide spectrum of practical issues of booting the operating systems and logical organisation of disk drives, file systems, the structure of executable files, mechanism of management of the Windows operating system, security in operating systems.

Practical component of students' educational activity was dominant. Students of second year, future bachelors of computer science and software engineering completed the practical tasks on analysing structure, functionality, principles of design of some operating systems with use of virtual machines. Special software for virtualisation was used for supporting educational activity on installing different operating systems and third party software. Methods of study operating systems with using of virtualisation are enough developed in modern pedagogical works. As an example we can suggest the research of O. M. Spirin, O. S. Holovnia [19]. The tasks that were suggested for students assumed a part of work to be done in classes and other part was homework. Each student work according to unique variant of the tasks, but some steps were very similar for all students. There were suggested 11 tasks for every student for the semester according to the topics of the curricular (see Table. 2). Each of these task contained both reproductive and creative steps with problem solving.

As the result of this work, students prepared and submitted reports using *Assignment* activity in the university personal learning system based on *Moodle*. So, we have possibility to monitor the time of completing the task by the student. The grades for reports with late submission were less. The reports that were prepared later than 2 weeks after deadline were not accepted by personal learning system, and students presented such reports to teacher in printed form personally with oral discussion. These reports with very late submissions have not analysed in this paper. In total, 54 students took part in experiment. 274 reports were analysed. The final test in written form has been suggested to students for evaluating their educational achievements. The results of this test were the base for study the connection between systematicity of student's learning activity and his/her educational achievements.

4 Results and discussion

Specific values of final test results were used for analysing correlation between systematicity of students' learning activity and their educational achievements (Figure 1). This values were calculated as ratio of test result of each student to maximal test result. The indicator of systematicity was evaluated as a part of reports, submitted in time by a student, that is as a ratio of the number of reports, submitted by a student in time, to the number of reports according to plan (11 reports for 11 tasks). Pearson correlation between these two variables is 0.28. This correlation is statistically significant at the significance level 5% for samples size of 54 that is enough in pedagogical researches.

Table 2. Topics of the practical tasks.

Content module	Topic
Operating system concepts	1. Analysing the *Reactos* operating system (installing and customising the operating system, doing some work in it)
	2. Analysing the *Kolibrios* operating system (installing and customising the operating system, doing some work in it)
	3. Analysing the *Ubuntu* operating system (installing and customising the operating system, doing some work in it)
Memory, treads and processes	4. Analysing active processes and threads in the *Windows* operating system (operating with processes and threads, obtaining the information about the active processes and threads using built-in and third-party software)
	5. Analysing CPU and memory managing procedure in the *Windows* operating system (simulating of the operating system scheduling with use of the special designed model *WinMOS*)
	6. Analysing the *Windows* virtual memory (getting the information and optimising RAM memory with use of built-in and third-party software)
Operating system management and resources	7. Analysing the structure of the *Windows* executable files (getting the information about files and its structure with use of the fields map and third-party software)
	8. Analysing the *Registry* in the *Windows* operating system (using and changing the registry information for managing the operating system)
	9. Analysing system services and drivers in the *Windows* operating system
	10. Analysing data security in the *Windows* operating system (working with accounts, encryption algorithms, digital signature)
	11. Analysing and optimising the Windows operating system booting

So, we can conclude that the part of reports, submitted by student in time, positively connected with educational achievements. What is the kind of this correlation? Three variants are possible: 1) systematic work according to the plan, given by the teacher, contributes for increasing educational achievements; 2) students with high initial educational achievements easily execute the tasks and submit their reports in time; 3) students with high competence in self-management of their independent work have high educational achievements at all and, in particular, use their skills to complete the tasks in time for higher grading. Both the

first and the third variants correspond the positive influence of systematicity on educational achievements.

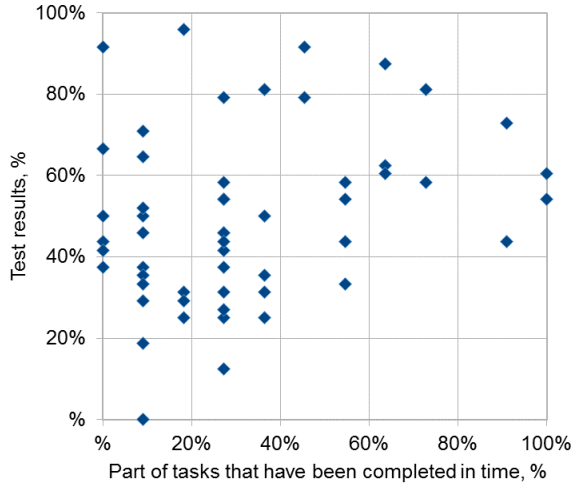

Fig. 1. Correlation between systematicity of students' learning activity and their final assessment results.

Analysing the diagram at Figure 1, we can see that the second variant was not realised: students with high test results (above 60 %) had systematicity indicator from 0 to 100 % and there was not any trend. Moreover, there was not any student with very high (above 80 %) systematicity indicator and test results simultaneously. So, we can see that the student with highest educational results did not work according to common plan even losing some grades. They, may be, worked systematically, but according to their own plans, so methodology of our experiment did not give us possibility to measure peculiarities of this work. Otherwise, they may be characterised by low level of importance of the learning activity results and high interest in the process of learning, and high cognitive interest. It should be appropriate to use for such students not the direct management of their independent work, but co-management or self-management.

Analysing the lowest boundary of points allocation at Figure 1, we can see that high value of the systematicity indicator (above 60%) guaranteed sufficient educational results (above 40 %). But students with highest systematicity indicator did not show excellent results in testing. This analysis gives grounds for hypothesis that the kind of management of student's independent work should be timely turned from direct management through co-management and subsidiary management to self-management according to the level of student's educational achievements and skills in self-managing for increasing the efficiency of educational process.

Choosing the day for completing the report, students taken into account many tasks in various sides of their life and study. But the fact that the number of reports, submitted in the last day, exceeds in near four times the number of reports, submitted in any other day (see Figure 2), show us the lack of students' competence in time planning and managing own work.

Did students work enough hardly in the educational process? Let us analyse diagram at Figure 3. We can see that students work at any time of day and night accept of period from 4 AM to 7 AM. In our opinion, such time scheme does not promote the learning of deeper questions of educational material, does not support productive and creative learning activity. This is not a problem of one course or one university, but a complex goal of development the methodology of education in direction to turning from reproductive methods of learning to more efficient students' activity with active use the information and communication technologies in education. We should take into account dual educational process, which is coordinated with professional-oriented practice work.

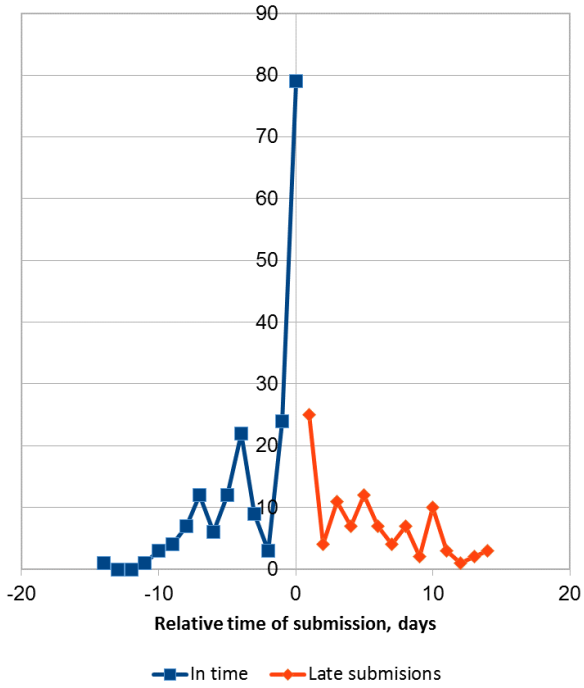

Fig. 2. Frequency distribution of students' report submissions by days relatively from the official deadline.

The deadline was set on Sunday at 11:55 PM. There was Saturday, free of classes. In some cases, students had more than a week to prepare their reports. But only 40 % reports were submitted in this period. Only 2 students used this period for stably work with every of their tasks. Our conclusion is to provide students with detailed direct management of their independent work at the initial stages of the course as well as to provide special training for increasing student's competence in time planning and self-management.

5 Conclusions

Analysis of obtained experimental data in context of our theoretical framework has given the base for such conclusions:

- systematicity of students' learning activity provide positive influence at students' educational achievements at low and sufficient levels;
- considering low students' competency in self-management and time planning it would be appropriate to provide students with detailed direct management of their independent work at the initial stages of the course

as well as to provide special training for increasing student's competence in time planning and self-management;

- kind of management of student's independent work should be timely turned from direct management through co-management and subsidiary management to self-management according to the level of student's educational achievements and skills in self-managing for providing the efficiency of educational process at highest level of educational achievements;
- students, who systematically complete educational tasks, have essential load that does not support productive and creative learning activity – turning from reproductive methods of learning to more efficient students' activity with active use the information and communication technologies in education is a complex goal of development of the educational methodology.

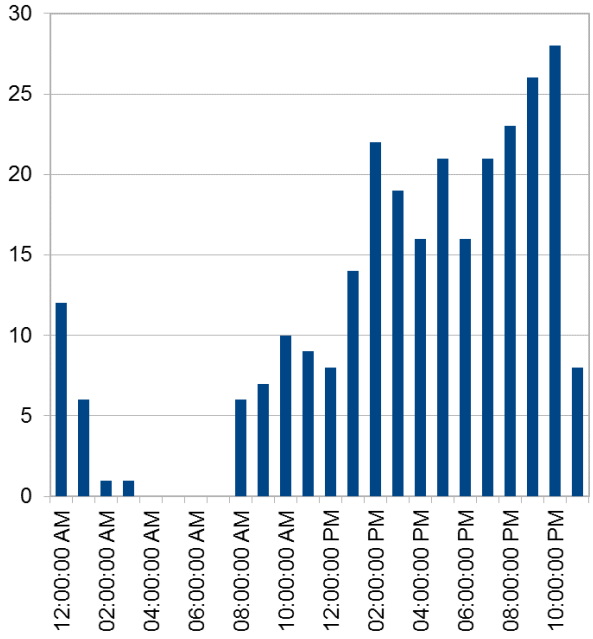

Fig. 3. Frequency distribution of students' report submissions by time, summarising all days (Deadline was 11:55 PM).

This study does not exhaust all the aspects in the field of creating of comprehensive student model for the systems of pedagogical diagnostics and prognosis. The main task in this direction is in obtaining a lot of experimental data about corresponding of some educational process indicators and efficiency of one or another methods of learning.

Concerning further development of the course "Operating Systems" we plan to introduce the management of student's independent work with more or less elements of self-management according to the features and educational achievements of a student. A good kind of developing learning management tools will be using such an interactive instrument as *Workshop* in the *Moodle* environment.

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