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Enhancing out-of-class independent learning in a cloud-based information and communication learning environment: insights from students of a pedagogical university

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Abstract. This paper addresses the challenges associated with students' out-of-class independent work in an information and communication learning environment that relies on cloud technologies. The study utilizes survey data gathered from students at a pedagogical university to inform the development of a course titled "Educational Electronic Resources for Primary School" designed for future primary school teachers. The findings reveal several prominent issues, including the need for more explicit instructions tailored to the task requirements, limited experience in self-management, and a lack of intrinsic motivation. Students emphasized the importance of detailed instructions, either orally or in written form, and emphasized the necessity of careful time planning to ensure successful completion of tasks. Furthermore, the article discusses students' learning activities and achievements in the course amidst the challenges posed by the COVID-19 pandemic. Drawing from this analysis, the study formulates key requirements for effectively managing students' out-of-class independent work in a cloud-based learning environment. This research contributes valuable insights to improving the design and implementation of remote learning initiatives, enhancing student engagement, and fostering meaningful learning outcomes.

Keywords: information and communication technology, cloud-based learning environment, pedagogical university, remote learning, independent learning

1. Introduction

Cloud Technologies is a basis of modern learning [47]. It provides the students with possibility of study that is free in space and time [38]. Students of full time learning also use the cloud pedagogical information and communication environment for out-of-classes independent work that become essentially actual in conditions of COVID-19 pandemic [69]. But learning activities in cloud environment essential differs from traditional work in classroom or homework with short-term tasks. It also differs from learning work on large study projects. New kind of learning

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activity requires new pedagogical studies in the field of didactic and psychological peculiarities of students' independent work.

Problems of educational activity in cloud environment were analysed in various studies. Liudmyla I. Bilousova [8] and her scientific school (which part we consider ourself) paid special attention to problems of management of the students' independent work in the information and communication pedagogical environment. Students' educational research with computational simulations has been developed as a method for improving students' self management through creative learning activity [6]. There was underlined in work of Bilousova, Kolgatin and Kolgatina [5] that effective management of student's independent work should be based on comprehensive computer oriented system of pedagogical diagnostics. Semerikov et al. [58, 59] have suggested to use computer simulation of neural networks using spreadsheets that give us possibility to introduce this modern technology in educational process of wide kinds of educational programs that are not directly connected with computer science. This field of research is very interesting for our present study, because it promotes development of educational research as a method of leaning. The elements of technique of using CoCalc at studying topic "Neural network and pattern recognition" of the special course "Foundations of Mathematic Informatics" are shown in the work of Markova, Semerikov and Popel [37]. The method of computational simulation and modelling is supported by works of Modlo and Semerikov [43], where new tools for modelling of electromechanical technical objects in cloud-based learning environment are suggested. Khazina, Ramskyi and Eylon [26] also consider computer modelling as a scientific means of training. So we can conclude that computational modelling and simulation is popular and actual learning method, which is actively used in cloud learning environment in particular for management students' independent work. This approach improve the level of learning activity to creative and promote students to self-management of their independent work.

Developing the university learning management system for blended study is one of the key issue of fundamental theoretical and practical studies in Kherson State University (Kravtsov and Gnedkova [33], Spivakovsky, Lvov and Kravtsov [63] etc.). Implementation of cloud service models into pedagogical information and communication environment is the subject of studies of Markova et al. [39]. The works of Nechypurenko and Semerikov [46] also lays in the field of creating the tools for improving the cloud learning environment and deals with creating a plugin that brings the VLab functionality into Moodle and allows to download and install the VLab files to the site with Moodle training courses. Another direction of developing students' learning environment is augmented reality software design for educational purposes that is caring out in works of Amelina et al. [1], Gayevska and Kravtsov [20], Kanivets, Kanivets and Gorda [24], Syrovatskyi et al. [66]. Now, we have comprehensive cloud learning environment that can support students' independent work and its management from direct through co-management, subsidiary management up to self-management [9].

The other side of investigations is devoted to the pedagogical theory of students' independent work management. Oleksandr V. Malykhin [36] is an author of one of the recent fundamental research, specifically oriented on the problems of management of students' independent work, he has suggested a model of the system of management of the students' independent learning activity in pedagogical university as well as the corresponded pedagogical technology, which has been tested at foreign language learning. Valerii Yu. Bykov [13] has developed the theory of modern net technologies of open education has analysed the appropriate models of the open

education organizational systems. There have been showed in this work [13] that we should take into account some styles of students learning activity: "Clarification of the student's learning style, its weaknesses and strengths – a necessary and important step towards finding approaches to structuring the content of learning, choosing effective pedagogical technologies (including individualized, group, interactive learning, distance learning, etc.), appropriate organization of the learning environment and inclusion to its structure of these or those means of training, a choice of pedagogical strategies and as a whole improvement of results of educational activity" [13]. Some directions of building the theory of learning styles are also signed in his work.

The basis of effective management of students' independent learning activities in higher education institutions is the study of the didactic conditions of management of students' independent work both theoretically and by means of a questionnaire [30, 60, 61]. Thus, according to [60] it is determined that third-year students during independent work had such difficulties as unclear requirements, lack of special literature, the discrepancy tasks with the subject of the course. The results of survey of students on the use of information technologies during independent work [42] are interesting for understanding the technique of students' work. As a result of this survey, students mostly use lecture summaries and electronic resources rather than textbooks or other teaching materials [42] in process of their self-preparation for classes. Survey method was used to determine the problems of self-study of primary school teachers in Luhansk Taras Shevchenko National University [53]. By results of [53], students often identify such difficulties, when performing independent work: not enough books (not enough information on the Internet), objectives or requirements are unclear, lack of time, trouble finding information, too large amount of information that makes it difficult to study. Survey [8], which deals with the problems of management of the students' independent work in the information and communication pedagogical environment, has shown that students widely use Internet resources during independent work, but they do it spontaneously and do not obtain proper effect on the success of learning. So management of independent work should be provided by special means in information and communication environment, aimed at improving the efficiency of the use of Internet resources during independent work of students [8].

Kolgatina [29] took attention for the level of cognitive students' activity in process of independent work and suggested the appropriate system of tasks for independent work on educational discipline "Method of teaching informatics". This tasks are focused on productive and creative activities of students and anticipate their implementation in the Moodle system. The author underline that the most positive results were achieved by students, who characterized by a high and average level of cognitive activity and a certain experience of independent work in pedagogical information and communication environment [29].

Despite the considerable interest of researchers to pedagogical conditions of students' independent work, the problem of empirical research of relations between factors, which determine the effectiveness of independent learning activities is still not exhausted. In particular, one of the actual problem in management of students' independent work in pedagogical information and communication environment is providing the systematicity of such activity. The lack of direct personal contact between student and teacher as well as the lack of personal connections between students during the task execution and presentation of its results needs innovation approach for motivation and help that traditionally provides learning process.

Objectives of this paper is the analysis of pedagogical conditions of providing the systematic

learning activity of students' in pedagogical information and communication environment at studying the course "Educational Electronic Resources for Primary School".

2. Theoretical background

On the basis of the analysis of psychological and pedagogical scientific works, it has been established that independent work of students is a multi-faceted concept and involves various aspects of its research: as a teaching method (Bondarevskii [10], Buriak [12], Kobyliatckii [27], Ruvinskii [56], etc.); as a type of activity (Bortkevich [11], Kasianenko [25], Kozakov [32], Lavrentieva et al. [34], Nilson [48], Nizamov [49], Okhrymovych, Shved and Hrebenyk [50], Semanov [57], Skakun [62], etc.); as a form of organization of the educational process (Esipov [17], Graf, Iliasov and Liaudis [21], Liaudis [35], Molibog [44], etc.); as a learning tool (Arkhangelskii [2], Garunov and Pidkasistyi [19], Pidkasistyi [52], Tolkunov [68], etc.). In our study, independent work of the student is considered as educational and cognitive activity which he carries out consciously and actively without direct participation of the teacher for the purpose of the set task decision.

Studying the problem of management of independent work of students involves, first of all, the identification of the essence of management, clarification of its role in the student's educational activities. Bespalko [3] believes that the diagnostic setting of teaching goals is an indispensable condition for the development of an effective pedagogical technology and we need to build a consistent model of the pedagogical process based on psychological facts and laws [3]. He has suggested some useful approaches to forming educational goals and building the indicators. We agree with this approach, which requires educational science to investigate the relationships between indicators that can be measured and learning outcomes that can be objectively diagnosed. At present, there is no sufficiently complete system of such indicators and patterns, so the purpose of our work is to try to assess individual patterns associated with the systematic nature of educational activity. Dmitrenko [14] also promoted a cybernetic approach in the study of learning process intensification. Some modern concepts of organization and management of students' independent work have been built in the study of Dmytrenko and Yaresko [15] from the viewpoint of cybernetic approach. Psychological aspects of management of students' educational and cognitive activity have been analysed in scientific works of Yakunin [70] and Itelson [23]. Psychological foundations of the management of educational activities have been grounded by Mashbits [41] from the viewpoint of using computers as educational tools. These theories are now used in wide fields of pedagogical studies. Monakhov [45] has suggested a modern prognostic model of development of the teaching theory for IT education. But these patterns are only phenomenological and can not directly become the base of automated pedagogical diagnostic and prognosis system.

An other side of the problem that is of researchers interest are assessment in students' independent work. Mashanova [40] paid attention to pedagogical control as a component of managing students' independent work. Now we believe that not only control, but a system of pedagogical diagnostics should be the base of such management [5].

There are a lot of scientific works that analyse practical results in students' independent work. Experience of management students' independent work in the higher medical school

has been shown by Filippova [18]. Independent work of senior pupils on mathematics in the conditions of differentiated education has described by Omelchenko and Voinalovych [51].

It was defined on the basis of works being observed above that the essence of managing the student's independent work is to implement the interaction of student and teacher, which is aimed at enhancing the student's activities in the educational process and to achieve the goal of learning. As a result of this interaction, the socio-cognitive experience of the student changes, which acquires the features of independent purposeful activity to gain readiness to solve future professional problems. Depending on the nature of the teacher's influence on the student's independent work, the types of management are distinguished [9, 28]:

- according the distribution of roles in the management between the subjects of the educational process – direct management, co-management, subsidiary management and self-management [9];
- by the presence of feedback – with feedback and without feedback;
- by the degree of individualization of influence – directed and dispersed;
- by level of using technical equipment – manual and automated.

From the standpoint of a cybernetic approach, the management is a process that is carried out in the following stages: collecting information and evaluating the situation; setting objectives; decision-making on choosing the appropriate method of solving the problem; realization of the decision; control and evaluation of results; adjustment. Each stage has a specific purpose and task assignments, provides for certain actions of the management entity. A teacher can only provide personal interaction with students to manage their independent work, when students' independent work is in progress in classroom. The management of out-of-classroom learning activity in traditional study is based on preliminary instructing, didactic tools and student's experience in self-management of own learning activity. Such situation leads to the lack of creative and productive activity in students' out-of-class study, because teachers have problems with management of such activity by traditional means. Only using the innovation pedagogical technologies, based on information and communication learning environment and cloud technologies, gives us possibility to realize on-line management of students' independent work at distance.

The development of information and communication technologies, in particular cloud technologies, creates the prerequisites for improving the efficiency of management of students' independent work. A number of scientific works is devoted to the practical didactics of the use of ICT for supporting independent work of students: programme languages for forming knowledge and skills in Informatics were used as first computer-based didactic tools (Ershov [16]); the dissertation of Reva [55] was one of the first works in the field of using applied software for independent work; some computational models have been designed by Synelnyk and Zavora [65] for organization of students' independent work; MathCAD environment was used in the course of computational mathematics (Bilousova, Kolgatin and Kolgatina [6], Bilousova [7]); Excel was adopted for computer modeling (Teplytskyi [67]); "Expert" software for pedagogical diagnostics was developed (Bilousova, Kolgatin and Kolgatina [5]); learning search algorithms with tools of cognitive visualization is one of the modern approach (Bilousova et al. [4]); educational software "GRAN" became a component of the system of information modelling

in the training of future teachers of mathematics and informatics (Horoshko [22], Zhaldak and Khomik [71]); complex introducing of ICT into mathematical education was developed by Rakov [54] and others. In these studies, attention was paid to the disclosure of new forms of educational and cognitive activity of students with the use of information and communication technologies. The analysis makes it possible to put forward a hypothesis about expediency of computer-oriented management of independent work of students in the process of teaching disciplines of the natural-mathematical cycle.

3. Empirical research of students' viewpoints

To determine the leading problems, which impede students' independent work, we suggested them some questionnaire with a multiple choice. The target group are students of pedagogical university – future teachers. The size of the sample is 53.

The question 1 suggests to the students some hypothetical "opinions" that characterize probable problems, connected with quality and fullness of preliminary instructing, motivation and cognitive interest, students' experience in self-management of independent work: "Sometimes it is difficult to complete a training task at the appointed time, the reason for this is often the following circumstances:" with such variants of an answer:

variant 1 – here is no enough understanding of how to complete a task;
variant 2 – there are other more important things;
variant 3 – there was a mistake in planning time, the task have been left for the last day and time was not enough;
variant 4 – bad health, illness;
variant 5 – the task is not of interest, it is difficult to force itself to borrow it, even if necessary;
variant 6 – fulfilling the task does not affect the achievement of my life goals (does not give the experience that will be needed in life);
variant 7 – the task does not affect my grades at the university (the grading system does not take into account the results of this task);
variant 8 – the task is so complicated (labor-intensive) that it is not possible to execute it.

The answers show (figure 1) that the leading problems are needs in more careful instruction according to features of the task completing, insufficient experience in self-management, the lack of internal motivation. Statistical analysis shows that influence of variants 2, 6, 7, 8, on the systematicity of independent learning activity is significantly less than the above factors (significance level 0.01 according to Pearson's criterion Chi-square). We should also take into account the variant 4, because of importance of health problems for a student as a person.

The same problems were analyzed by students during answering Question 2 from the other viewpoint. The question 2 suggests students to choose some hypothetical "recommendations" for teachers: "To improve the systematicity of students' work, I would recommend teachers:" with such variants of an answer:

variant 1 – not to give for independent work of creative tasks, the order of execution of which is not known in advance;

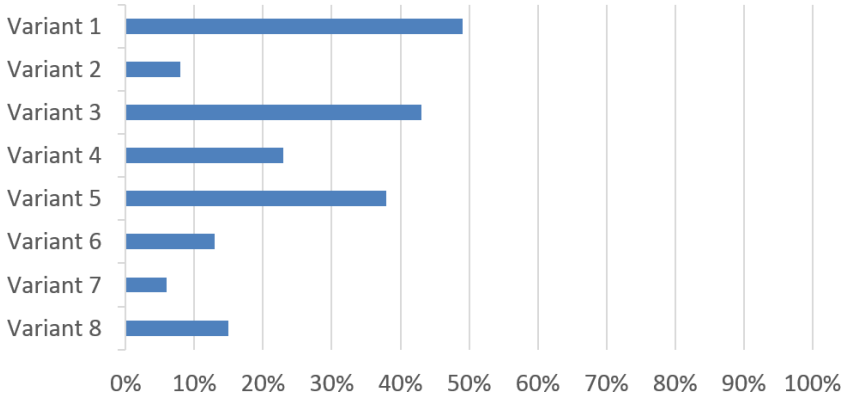

Figure 1: Percentage of students' choice according to Question 1 [28].

variant 2 – not to give for the independent work of tasks of a reproductive nature, which is not interesting to perform;
variant 3 – to provide a detailed written instruction to complete the tasks;
variant 4 – to conduct oral consultations and demonstrations in relation to the execution of tasks;
variant 5 – to reduce the grading score for the violation of the term of the tasks;
variant 6 – to provide multiple reminders about the near deadline of the results presentation, using the means of communication;
variant 7 – to calculate the time on the task carefully.

Most of all (figure 2), students recommend to provide the tasks with detail instruction (oral or written) and to pay attention to careful planning the time that is necessary for full completion of the task. Other variants (1, 2, 5, 6) were chosen significantly less (significance level 0.01 according to Pearson's criterion Chi-square).

Such answers to Question 2 confirm the answers to Question 1 (Variants 1 and 4), but are in conflict with variant 5 of Question 1. To increase the cognitive interest of the task we should

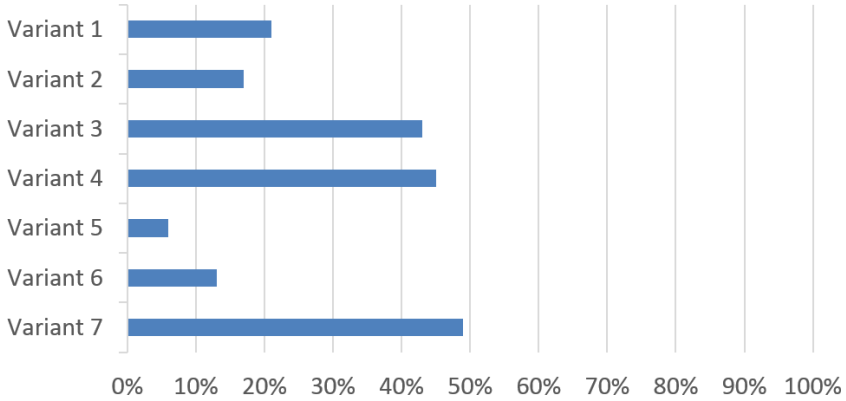

Figure 2: Percentage of students' choice according to Question 2 [28].

suggest creative tasks for the students, but such tasks are difficult. If the preliminary instructions are very detailed – we'll lost the creative component in the task. So detail instruction should be provided only in needs in time. This instruction should be individual for the student. One teacher cannot serve all students of academic group in such regime, so we need to organize the collective work of students in information and communication learning environment. We need to use the automated system of pedagogical diagnostics for control every student activity and providing him with context help [5]. There are experimental researches [64] and theoretical studies [13] that stress an attention on accordance between student's learning styles and the used method of teaching, "... the way the material presented in online electronics course" [64]. So the automated pedagogical diagnostic system should be comprehensive enough to determine appropriate student's characteristics.

As a result of this discussion let us to formulate some requirements for management of students' out-of-classroom independent work:

- availability of information and communication learning environment which is useful for students;
- students experience in self-management of own learning activity – this experience is provided by systematic independent work, which step by step transforms from direct management by teacher throw co-management with a teacher to self-management according to objectives, plan, system of learning tools and recommendations from teachers and the automated system of pedagogical diagnostics;
- creative elements in the system of learning tasks;
- students' cooperation and communication in process of independent work that increases motivation, helps to follow the time plan and to overcome problems;
- availability of the automated system of the pedagogical diagnostics that provides a student with help in pedagogical design of his learning activity;
- careful design of the system of learning tasks individually for each student with time planning.

4. Courseware structure and background of empirical study

The results of this students' opinions analysis were taken into account at developing courseware "Educational Electronic Resources for Primary School" in learning management system Moodle for future teachers of primary school of the third year study. The purpose of teaching this discipline is for students to master multimedia technologies and gain skills in designing educational electronic resources. The main tasks of studying the discipline are: mastering the theoretical aspects of the use of educational electronic resources; acquaintance with a set of psychological and pedagogical, ergonomic, technical and health requirements for educational electronic resources; mastering the methodological principles of designing author's educational electronic resources; gaining practical experience in developing author's electronic resources to organize the assimilation of educational material by students, to control their academic achievements. Students' competencies in independently finding the necessary resources, its analysing and mastering are in the main focus of this curricular.

The content of the course has been developed according to such topics: stages of information technology history; requirements for educational electronic resources; features of educational electronic resources design; development of educational electronic resources; online support for teachers activity. This course is practical oriented, so interactive and communicative elements are the main part of the courseware: workshops, wiki pages, tests, assignments, databases. The educational process was realised as blended learning, but in conditions of COVID-19 pandemic the weight of online work was essentially grater than it is normal for the blended learning [31]. We had a distance educational process factually. So we shell believe that ZOOM sessions realise class work (with high level of independence) and all other students' educational activity is independent work out of class.

Such situation gave us possibility to study systematicity of students' learning activity, because the level of their independence was extremely high. We have used assignments to study the objective situation with systematicity of students' learning activity. These assignments were used for the students to upload reports on completing tasks for out of class work. These tasks contain both creative and reproductive elements, so it satisfy the requirements that are the result of our survey. Creative component assumes solving problems that are new for a student, free searching the resources and possibility to variance the results. Reproductive component was provided by the detailed instruction for methods of solving a problem. Management of students' independent work was realised by this instructions and online or offline teacher's personal consultations. Students' cooperation and communication were organised with a chart and e-mail. Automated system of the pedagogical diagnostics was based on a built-in test system of Moodle and gave teacher possibility of flexible management that assumes on time decreasing the level of management from self-management or subsidiary, or co-management up to direct management using additional consultations [9]. Table 1 contains titles of the considered tasks. The number of students that took part in this work is 14.

5. Results and discussion

Our analysis of the empirical results was directed to produce recommendations for better students' independent work management from the viewpoint of systematisity. First of all we observed that there were a group of students, who completed the tasks and uploaded the reports on time as a rule. But some students uploaded their reports essentially later or not completed some tasks at all (figure 3). Therefore, we can conclude that the systematicity of learning activity is an element of student's personal style of learning activity.

Can the late submissions be of better quality because some students spend more time doing it? No, our observations show that the late submissions were not of good quality. Some students downloaded many report files in a short period of time and even at night. To prove this observation we need some statistical analysis. Let grade each student's submission in two scales: 1) the grade of quality (in percent of maximum grade according the curricular) and 2) the grade of systematicity (1 – for on time submissions; 0 – for late submissions). So we have two variable and can evaluate correlation between them. This is point-biserial correlation, so we need to use special correction that increase the value of Pearson's correlation. But this correction is only grounded for normal distribution of the point scale, otherwise we can obtain

Table 1
Indicators of students' work systematicity on the base of assignments.

Assignment title	Number of reports that were uploaded on time	Full number of uploaded reports	Correlation with the grade for quality	Correlation with the total number of reports that were uploaded on time
Characteristics of educational electronic resources	9	13	0.82	0.57
Functions of educational electronic resources	5	14	0.53	0.90
The degree of didactic functions implementation	6	10	0.79	0.67
Characteristics of an educational computer game	5	7	-	0.83
Examples of interactivity	6	11	-	0.66
Crossword	7	12	-	0.88
The simulator in the MapKit environment	6	8	-	0.83
The simulator in the Match environment	6	6	-	-
Interactive presentation	6	12	0.69	0.79
The main didactic function of the educational electronic resource	5	10	0.8	0.88
Examples of educational research tasks	3	10	-	0.68
Characteristics of sites	6	13	-	0.77
Laws and regulations on the creation and use of didactic electronic resources	8	13	-	0.76
Advantages and limitations of offline and online e-resources	7	12	0.52	0.65
Animation	5	8	-	0.89

correlation more than 1. We can not prove this fact because of a small size of a sample. So, we'll use the ordinary Pearson's correlation to demonstrate the effect and some non-parametric significance test to prove statistical significance of this effect, understanding that our evaluation of correlation will be a little smaller and never equal 1. The results of evaluation Pearson's correlation between systematicity and the grade of quality are shown in the table 1. Correlations for some assignments have not been evaluated because the teacher has graded all students' submissions with equal maximum grade point. We need in additional proving significance of this results because of the lack information about the distribution law of our data. So we have prepare 2×2 contingency table with two groups: 1) students, who have uploaded the report on time; 2) students, who have uploaded the report later; and two categories: 1) students, who's report has been graded by maximum grade points; 2) students, who's report has been graded by less than maximum grade points (table 2). Using Pearson's Chi-square test or Fisher's exact test shows that the systematicity and quality of submissions are not statistically independent at high significance level.

The other side of the problem is optimising the task system for the students with different

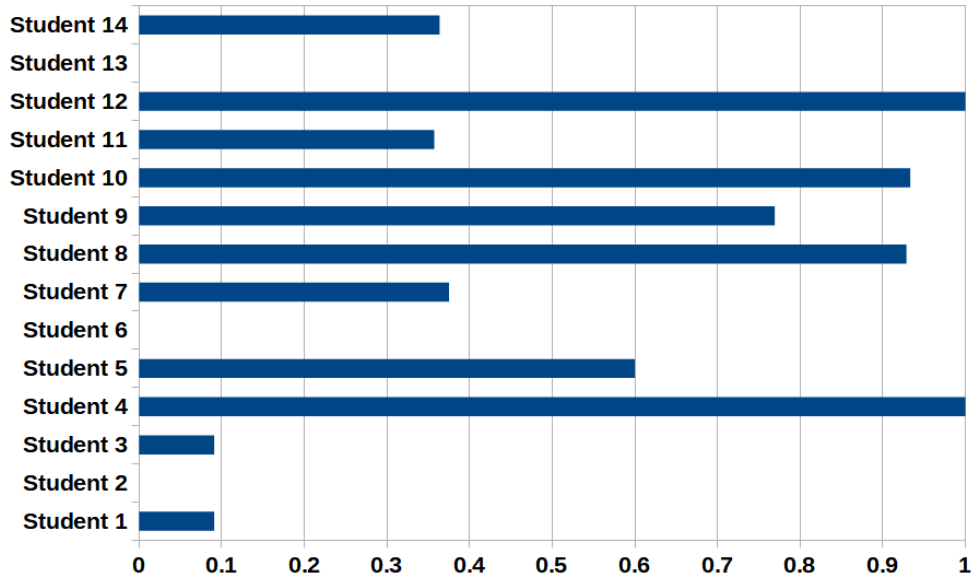

Figure 3: Proportion of tasks that a student completed on time.

Table 2
Contingency table for significance test to prove dependence between submissions timeliness and quality.

	Max grade	Less grade
On time submissions	76	0
Late submissions	46	20

level of their learning activity systematicity. We tried to find some differences in completing our tasks by students with different total systematicity level. Correlations between the the grades of systematicity for a task (as it was describe above) and total number of tasks that have been completed on time by a correspond student have been evaluated for each task and are shown in the table 1. This values are indicators of internal integrity of our task system. We cannot find any essential differences between behaviour of students with high and low level of systematicity according. This result is negative from the viewpoint of developing recommendations for designing special tasks for students with low competence in self management, but it is positive from the viewpoint of the course quality.

6. Conclusions

1. As a result of survey among students of pedagogical university, the most common problems in systematicity of students' learning activity during the independent work in cloud environment 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.

2. Some requirements for management of students' independent work for fixing these problems are suggested and particularly realised in the course "Educational Electronic Resources for Primary School" for the future teachers of primary schools:
    - information and communication learning environment should be available and useful for students;
    - students should continuously capture the experience in self-management of own learning activity;
    - the system of learning tasks should assume elements for creative students' learning activity;
    - students' cooperation and communication in process of independent work should increase motivation, help to follow the time plan and overcome problems;
    - the automated system of the pedagogical diagnostics should be worked out to provides a student with help in pedagogical design of his/her learning activity;
    - design of the learning tasks system should be individual for each student and assume accurate time planning.
3. It has been shown on the base of our experience that student's trend to complete learning tasks on time or not was stable from one task to another, so this trend was mostly determined by student's style of learning activity and other random factors did less influence.
4. Statistical analysis of the experimental data has shown that systematicity of student's learning activity (as a trend to complete learning task on time) correlates with better quality of this activity results. So it is expedient to motivate students to systematic learning activity, to form correspondent competences of self-management in independent work and to help them with time planning.

7. Prospect for future research

When distance learning started to be introduced as an element of the educational system, enthusiasts took part in such learning activity mostly. Students had enough competences in self-management and high motivation. Now, online information and communication technologies become the key part of mass education of ordinary students, who are not ready to self-management. So we need in new pedagogical technology, oriented for educational process with essential part of students' independent work that is managed distantly with use of information and communication technologies.

Students' ability to study regular without direct time planning become very important for the success of educational process. And we need to find and systematise pedagogical methods for forming appropriate style of learning activity and competences. We also need to analyse and systematise the features of educational tasks that promote student to systematic and regular work. We should investigate the boundaries of expedient systematicity as the final stage of this work.

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