Introspection as a Condition of Students' Self-management in Programming Training

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Abstract: The paper is devoted to the study of types of managing the student's educational activity. The educational discipline "Practicum of problem solving in informatics" for students of third year study, future teachers of informatics have been chosen for realising pedagogical conditions of computer-oriented management of students' educational activity. Progressive turn from direct management through co-management, subsidiary management to self-management was the main idea of designing the courseware. The information and communication educational environment has been based on the platform of learning management system Moodle. The Workshop elements of Moodle played the central role in management of students' educational activity. The results of our pedagogical observation and assessment showed the efficiency of suggested approach. Additionally, there were shown the lack of students' competency in time planning and introspection on the base of the experimental data.

1 INTRODUCTION

1.1 Statement of the Problem

Informatisation of the educational process has led to the creation of information and communication educational environment in institutions of higher education and significantly influenced the goals, content, methods and means of students' educational activity, forms of its organization. The use of modern powerful computer tools for implementation of management tasks in educational process means the transition to a new type of management – computer-oriented, which can provide the personalisation and not only serve the achievement of learning goals, but also help the student to become the active participant of such management, that is the subject of self-management. The use of information and communication technologies is connected with developing innovative management practices and introducing these technologies to educational process. There are many theoretical and practical studies in this field, but it remains relevant today.

1.2 Analysis of Previous Research

One of the most fundamental analysis of theoretical and methodological aspect according to the management of the independent learning activity of students of pedagogical higher educational institutions was suggested by Malykhin (Malykhin, 2009). Recently, appropriate methodical systems have been introduced into the practice of the educational process to provide for computer-based management of students' educational activity. Information and communication educational technologies, especially, cloud technologies that transform education have been analysed according to results of the "Cloud Technologies in Education" workshop (Kiv et al., 2020). Lavrentieva et al. (Lavrentieva et al., 2019) have analysed new methods of the organization of students' independent study activities together with the use of ICT and tools.

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Computer-based tools of supporting students' independent experimental activity in the process of learning quantum physics have been proposed by Velychko and Shulga (Velychko and Shulga, 2018). Management of students' educational activity was provided as support in instrument setup, measurements, results processing. Vlasenko et al. (Vlasenko et al., 2019) have designed and are developing an educational site "Differential Equations" to support students' educational activity. The site contains theoretical framework, practical classes, provides consultations online and via e-mail, testing, discussion cases, forum and provides support for the teaching of the course and solving practical problems of research character by students. Podlasov et al. (Podlasov et al., 2017) have proposed elements of blended training in physics at a technical university on the basis of programmed learning (students study new material or fixate their knowledge) in the Moodle system with the help of the element Lesson. Kyslova and Slovak (Kyslova and Slovak, 2016) developed methods of using the mobile learning environment in study of higher mathematics by future electromechanical engineers. These methods are based on the complex application of computer tools: using Google Apps Education Edition (texts, diagrams, links, videos); execution of practical tasks and research with developed models in cloud-oriented GeoGebra and CoCalc environments; application of Drawings for generalization and systematization of concept connections, Forms for testing, CoCalc for task generation. Tools integration was provided with using Classroom, Calendar was used for scheduling training activities. Triakina et al. (Triakina et al., 2018) analysed E-learning instruments for self-education and have suggested the ways of this tools implementation into professional training. Methods and technologies for the quality monitoring of electronic educational resources were analysed by Kravtsov (Kravtsov, 2015). Pinchuk et al. (Pinchuk et al., 2019) stressed flexibility and adaptability of pedagogical systems as principals of a substantial transformation of the education system. Realisation of these principals needs in comprehensive pedagogical diagnostics and prognosis in educational process. A methodical system of computer-oriented management of independent work of future teachers in the process of learning computational methods (numerical methods) was developed by Bilousova et al. (Bilousova et al., 2019). This system is based on the use of specially designed computational models in MathCAD environment and assumes learning management system Moodle to support for management of students' independent work. It should be noted that development of the educational process on the basis of its reorientation to students' self-management their own cognitive activity not only contributes to enhancing the autonomy of students, but also gives the education of personal significance. By determining the individual trajectory of educational and cognitive activity of each student on the basis of the maximum consideration of his individual and cognitive abilities, the necessary prerequisites for the formation of his skills of systematic and continuous professional self-improvement are created. Useful analysis in this direction were suggested by Kruk and Zhuravleva (Kruk and Zhuravleva, 2010). Santos et al. (Santos et al., 2012) suggested a tool for empowering students to reflect on their activity. Special analysis of a way and steps for transforming students' independent work management from direct to self-management was suggested by Bilousova et al. (Bilousova et al., 2020). This theoretical analysis was implemented in training process of future teachers of informatics that gave authors possibility to see binds between students' introspection and competence in self-management. Self-regulated learning were discussed by Nussbaumer et al. (Nussbaumer et al., 2012). They stressed that the cognitive and meta-cognitive activities are not directly measurable, so the measurable actions should be mapped to cognitive and meta-cognitive learning activities (Nussbaumer et al., 2012). But known results observed in our review are not enough to built completed model of a student for pedagogical prognosis.

1.3 Objectives

The potential of computer-oriented management of students' educational activity is not fully realized, according to the above analysis. It actualizes the study of pedagogical conditions, the introduction of which improves the effectiveness of such management. We should find the methods to contribute students in obtaining better educational results and in acquisition of the active personal position in managing their own independent work. We also need in some approaches to measuring the parameter of the model of a student for pedagogical prognosis and effective choosing appropriate type of management. This task is complex and very complicated, so it can not be solved in a single study. Our work is directed to solving this problem by studying some elementary issues of student model and correlation some its parameters with efficiency of some management type.

The purpose of this paper is theoretical and practical study of introspection as a pedagogical condition of effective computer-oriented management of students' educational activity in information and com-

munication educational environments.

2 THEORETICAL FRAMEWORK

There are various approaches to defining the concept of management in pedagogical systems in the psycho-pedagogical literature. Thus, Markov (Markov, 1978) views management as an organization of purposeful actions, Itelson (Itelson, 1964) sees management as the actions that are directed to achieving a previously set goal. Korshunov (Korshunov, 1987) considers that management is the organization of a process that ensures the achievement of a predetermined goal. Filippov (Filippov, 1980) considers management as the purposeful influence of the subject on the object and the change of this object as a result of influence. Nechaev (Nechaev, 1992) speaks about management as purposeful regulation of processes. In some studies, management is seen as an element of some system that connects all its elements and subordinates them to the goal. Thus, Yakunin (Yakunin, 1988) sees the essence of management in the interaction of the student and the teacher, which is carried out in accordance with the set goals and is aimed at activating the student's activity in the learning process and achieving the required results. We agree with all of the above statements, which highlight certain features of management and confirm the relationship between management and activities. It is also defined by the new interpretative dictionary of the Ukrainian language: "To manage - 1. To direct activity, work of someone, something; be led by someone, something; manage. 2. To direct the course of a process, to influence the development, the state of something" (Yaremenko and Slipushko, 1999). On the basis of this analysis of pedagogical research on the problem, the essence of managing student's educational activity is determined as realization of interaction of a student and a teacher, which is aimed at activating student's activity in the educational process and achieving the educational goals. As a result of this interaction, the social and cognitive experience of the student changes, which acquires the trait of independent, purposeful activity in order to become ready to solve future professional problems.

The development of information and communication technologies creates prerequisites for improving the efficiency of managing students' educational activity in modern higher education process. Given the new role of the teacher as a tutor, a moderator, who provides support to the student in choosing and building an individual educational trajectory, the new quality of management is seen in its variability, coordination of management actions with individual capabilities, needs and requests of the student. This management is directed to help the student to get knowledge and skills according to the curricula, but also to increasing involvement of the student in managing their own educational activity, in the progressive transition from direct management to co-management, subsidiary management and further to self-management. ICT-oriented management of student's educational activity is a multi-stage process (collection of information, statement of objectives, decision-making, implementation of the decision, monitoring and evaluation of results, adjustments) that is implemented with the use of appropriate ICT tools at each stage. Implementing student's self-management with the use of modern, powerful computer management tools means moving to a new type of management – computer-oriented, capable to provide higher quality of management. This new quality can not be proved theoretically, but it was observed in educational process. We have analysed our previous empirical work [hide for peer review] and can highlight the most important features of computer-oriented management of student's educational activity:

- adaptability that is based on detailed data on the level of knowledge and skills required for independent work, as well as on the dynamics of their acquisition;
- flexibility that assumes gradual involving of a student in improving management of his/her own independent work through the transition from direct management to co-management, subsidiary management and self-management on the base of analysis of the accumulated experience of using a certain type of self-management and data on its effectiveness;
- timeliness, which is provided by the opportunity to monitor the process of the task execution and the availability of communication resources, that allows timely and targeted assistance and advice to the student, based on the accumulation and analysis of data on the progress and effectiveness of his educational activity;
- transparency, which involves openness of requirements to the results of the educational activity, criteria for the evaluation, rating indicators of student's educational achievements;
- objectivity in making managerial decisions that is based on objective testing data and tracking the effectiveness of the student's educational activity.

Pedagogical conditions for the effective implementation of the said management in the educational

Table 1: Activities of the subjects of the educational process at different management types on the stage of implementation of the decision.

Type of management			
Direct management	**Co-management**	**Subsidiary management**	**Self-management**
The teacher sets a task for the student	The teacher discusses a task with the student	The student chooses a task from a database	The student formulates a task and coordinates it with the teacher
The teacher sets the methods of the task execution	The teacher discusses the methods of the task execution with the student	The student chooses the methods of the task execution from suggested by the teacher	The student determines the methods of the task execution independently
The teacher suggests necessary resources to for the student	The teacher suggests necessary resources to for the student	The student chooses necessary resources from the given resource base	The student determines the necessary resources independently
The teacher gives the example of the correct operation sequence (detailed instruction)	The teacher gives the common schema of the operation sequence (framework instruction)	The student determines the operation sequence independently	The student determines the operation sequence independently
The teacher provides current correction of the task execution process	The teacher adjusts the process of completing the task, if necessary	The teacher adjusts the process of completing the task, if the student ask him for help	The student controls the task completing process independently
The teacher provides the student with current systematic help	The teacher helps the student, if necessary	The teacher helps, if the student asks	The teacher helps, if the student asks
The teacher gives the pattern of report to summarising obtained results. The student acts according the model	The teacher gives the plan of report to summarising obtained results. The student acts according the plan	The teacher gives the requirements to report and summarising obtained results. The student produces the analysis of obtained results independently	The student coordinates the form of report with the teacher and produces the analysis of obtained results independently

process have been substantiated on the basis of analysis of the new opportunities for managing the student's educational activity:

- designing of information and communication educational environment, which contains variation educational-informative, instructive-methodical, software-instrumental, as well as communication resources for organization and support of the student's educational activity;
- using a system that automates the collection, accumulation and analytical processing of performance indicators of student's educational activity;
- ensuring the readiness of all participants in the educational process to implement computer-oriented management of the student's educational activity.

The above pedagogical conditions was checked in the comparative pedagogical experiment in the PhD thesis of one of the present paper authors. The results of this experiment have proved that abidance of suggested pedagogical conditions contributes increasing the efficiency of computer-oriented management of independent work of future teachers in the process of their natural and mathematical training.

Only comprehensive application of all conditions ensures the effective management. The implementation stage of ICT-oriented student's educational activity management is the key stage, when the student actively takes part in this management as the person of educational process. Understanding the character of interconnections between the teacher and the student (table 1) is very important for developing the flexible management based on different types of management (direct management, co-management, subsidiary management, and self-management) (Bilousova et al., 2020).

3 METHODOLOGY OF EMPIRICAL RESEARCH

We have realised the above approach to management of students' educational activity in the students' training in programming. The information and communication educational environment has been based on

the platform of learning management system Moodle. It contained built-in communication resources as well as reference to educational-informative resources and instructive-methodical materials according to programming the basic algorithmic constructions for organization and support of the students' educational activity.

The first stage of empirical work was realised in practicum of problem solving in informatics for future teachers of informatics. 10 students took part in this work. The software-instrumental resources (Eclipse environment and the tools of common information technologies) were present at every students' computer. The leading information channel was the interactive lectures, where the elements of programs have been analysed in details. The educational activity of the students at this interactive lectures were managed directly, because the students did the notes in the form of parallel development the suggested and analysed algorithms as Java programs. Interactive parts of this lectures involved some students in co-management of educational activity, but some of them were passive and continue execute the tasks in direct management regime, using the ready fragments of code and orientating only at the teacher's commands in the time planning. The students' notes in the form of developed and tested programs became the instructional materials for management students' independent activity in problem solving.

There were created 5 Workshop elements of activity in the course in Moodle environment and suggested 5 series of individual tasks for each student according to the such topics: linear algorithms; branching; cycles; one-dimensional arrays; two-dimensional arrays. There were 10 variants of tasks, so each student obtained individual variant. The example of full task series for one of these variants is shown in table 2. Every of this series contained three tasks of different levels. Student should complete one of this task for passing or all tasks for high grade. The first task assumed the direct (but distance) management of students' educational activity, because this task was very similar to the one was analysed at lecture. The second task assumed the direct or co-management. This task was based on some of analysed algorithms but was not fully similar. Students could solve this problem using only the lecture notes (direct management). But sometimes students needed in additional information for solving the problem. They could ask the teacher or colleagues personally or using the built-in tools of Moodle (co-management) as well as to use some additional information resources (subsidiary management). The third task was difficult and assumed using the algorithmic constructions that were not analysed at lectures. Students had to discuss this problem with the teacher (co-management) or independently use the additional information resources (subsidiary management). So, the students independently and intuitively made the decision on using some of above type of management of their own educational activity for each task according to their educational achievements and skills of independent activity.

Students uploaded the results of the tasks execution to the Workshops. It should be the correct program with the author's tests to prove it correctness. The second phase of students' activity in Workshops was to check and grade the works of the colleagues – assessment phase. Only the students, who have executed the first stage of the task and have submitted their works, could take part in the assessment. The assessment process is creative activity, but its management was direct, because the students assessed according to the simple instruction: +1 point, if the program is submitted and perform the required results; +1 point, if the program correctly work with the author's tests, +1 point, if the reviewer cannot suggest any tests to indicate the bugs. Grading of the assessment phase was produced automatically by comparison of student's given grades with other reviewers' grades for corresponding works. Teacher also took part in the assessment as a reviewer with weight coefficient of 10. This procedure represents our method of evaluation. So, the student's grade for submission is a sum of the grades for three tasks and the grade for each task is from 0 to 3 as it was described above. The student's grade for assessment was evaluated automatically with a built-in algorithm of learning management system Moodle for the Workshop element.

The teacher carried out pedagogical observation during the course. Students, who did not submit their works in time, passed each task at additional time in the form of discussion of the results with the teacher personally. Such results were not analysed in this study.

There was the final test for future informatics teachers at the end of the course. This final test took place in a classroom at fixed time under the teacher observation. The students were suggested to design three programs of different difficulty levels with using algorithmic elements of different topics. The students, who completely designed the program for the satisfactory level could obtain up to 74 grade point. In case of errors the grade was decreased. When the satisfactory level was passed successfully, the student was suggested with a task for sufficient level (up to 89 grade points). And finally, a task for high level was suggested. Some students could not satisfactory pass this test in fixed time. They had additional at-

Table 2: Example of tasks set for workshops.

Topic	The First Task	The Second Task	The Third Task
Linear Algorithms	Develop a program for calculating the income of a family of 4 people for the specified income of each family member	Develop a program to calculate the rest when buying n units of goods at a price of x_1 dollars x_2 cents, if the box office submitted y_1 dollars y_2 cents	Develop a program to calculate the amount of money to buy n CD disks, if each individual CD disk costs x hryvnia, and a box of ten CD disks is sold at a discount of y percent
Branching	Develop a program to test knowledge in the history of science according the following scenario: 1) the computer submits the task: "Year of birth of Serhii Oleksiiovych Lebediev – an outstanding scientist, under whose leadership the first computer in the continental Europe was built"; 2) the user enters the answer as an integer number; 3) the computer compares the user's answer with the correct one (1902) and informs the user about the result of the check.	Develop the program which on the set air temperature recommends clothes: • less than minus ten – "coat"; • not less than minus ten but less than plus ten - "jacket"; • not less than ten but less than eighteen – "sweater"; • eighteen and above – "does not matter"	Develop a program that determines whether the brick will pass into a rectangular hole, according to the specified size of the hole (a,b) and the brick (x,y,z). Input may be not sorted in ascending order.
Cycles	In the treasury of the fairy kingdom are jugs of living water. All jugs are numbered sequentially. The amount of water in each jug is determined by the magic formula $\frac{i^2+1}{2i}$, where i is the number of the jug. Develop a program that for given numbers i_1 and i_2 finds the total amount of water in the jugs from i_1 to i_2 inclusive.	For n numbers entered from the keyboard, compare the count of positive and negative numbers	For n numbers entered from the keyboard, find the length of the maximum series of numbers that are ordered in ascending order. Do not use the array
One-Dimensional Array Processing	Replace the surnames "Danko" with "Tanko" in given array of surnames	Delete items that are equal and next to each other from given array, which contains a list of company names	Two arrays of surnames are specified. Elements with the same index define the ancestor – descendant pair. Develop a program that identifies all the ancestors of a person by a given surname and writes their surnames to a new array in chronological order
Two-Dimensional Array Processing	Replace all negative elements of the 2D array with zeros	A square table is specified, each element of which determines the distance between cities. Assume that there are no errors in the table. Find pairs of cities with the minimal distance between them.	A rectangular table is given: the number 1 indicates land, and the number 0 indicates water. Determine the number of islands. Assume that from one cell you can go to another "by land" if they are located next to each other vertically or horizontally.

tempts, but only the results of the first attempt were used in the present study.

The second stage of our empirical work was realised in the course "Algorithms and data structures" for future bachelors in Computer science (Software and applications development and analysis). We used

the same series of tasks that was suggested to students by Workshop elements in Moodle personal learning environment. The kind of grading was the same as one on the first stage: +1 point, if the program is submitted and perform the required results; +1 point, if the program correctly work with the author's tests, +1 point, if the reviewer cannot suggest any tests to indicate the bugs. Students took part in the grading together with a teacher, it was anonymous peer review process. This work supported developing students' skills in introspection and promoted them to self-management of their own independent work. The analysis of students' review used in this paper to describe binds between quality of such grading, quality of submissions and student's introspection competence.

The pedagogical environment was essentially differ from the one at the first stage because of different educational programs and influence of the COVID-2019 pandemic. Microsoft Visual Studio (C++) was used as the software-instrumental resources. All students solved these problems out off classroom. There were only review lectures and one practical work in class rooms, because COVID-2019 pandemic have started. So the students have not been equipped with examples of solving similar problems, but they had some experience in programming as a result of passing previous courses according the curricular. We can believe that management of students' independent work in problem solving was subsidiary or self-management. Personal learning environment in Moodle was the key component of the courseware. The leading information channel was the interactive lectures realised in Lesson element of Moodle (direct management with answering short questions after each portion of information) as well as the teacher consultations in built-in messenger (co-management). The system of pedagogical diagnostics was based on analysing workshop submissions and assessments, built-in lecture testing, results of final tournaments in programming. The material on base algorithms for linear data structure processing (linear algorithms, branching, cycles, one-dimensional arrays processing, two-dimensional arrays processing) covers only first module of the course in contract with the curricular of future teachers of informatics.

There were not the final test for future computer science bachelors because of COVID-2019 pandemic. So we needed another values for comparison the students' educational achievements with characteristics being investigated. We used the results of automated testing during the students' work with Lesson element in Moodle. There were 6 of such interactive lectures in the course (not only for the investigated topics). The questions were both theoretical and practical. A student could try to pass the lecture so many times as he/she wanted. We used the highest test results for each lecture as the test value. The average of these test values across the course were calculated to obtain appropriate characteristic for each student. Also the average time that students used for lecture studying and testing was analysed as an additional characteristic of student's style of learning.

Students had possibility to pass the course without taking part in suggested workshops by independent studying correspondent material using the Internet and taking part in tournaments to show their competences. 11 students – future bachelors of computer science have taken part in the workshops.

4 RESULTS AND DISCUSSION

4.1 Future Informatics Teachers Introspection

Correlation between students' final test results and students' average grades for submitted works has been evaluated to estimate the validity of our assessment tools on the sample of future teachers of informatics (figure 1). Coefficient of Pearson's correlation is 0.70 that is statistical significant at the 5% significance level.

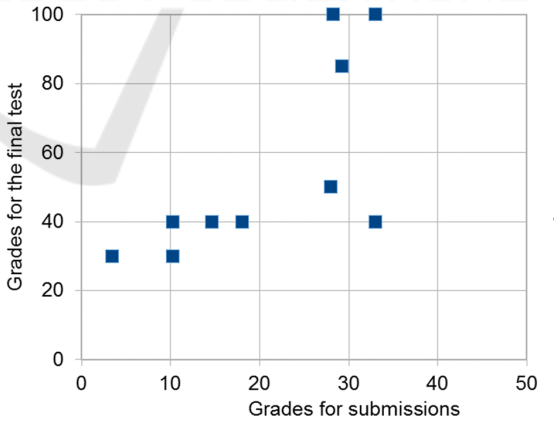

Figure 1: Correlation between students' final test results and students' average grades for submitted works (future informatics teachers).

Correlation between the quality of tasks execution by students and their skills in assessment seems to be very good for 7 students (figure 2), but 3 students with highest results of tasks execution did not take part in assessment, so we cannot prove this correlation statistically, the size of our sample is not enough. Accord-

ing to our pedagogical observation, some students did not take part in the assessment because of their mistakes in time planning.

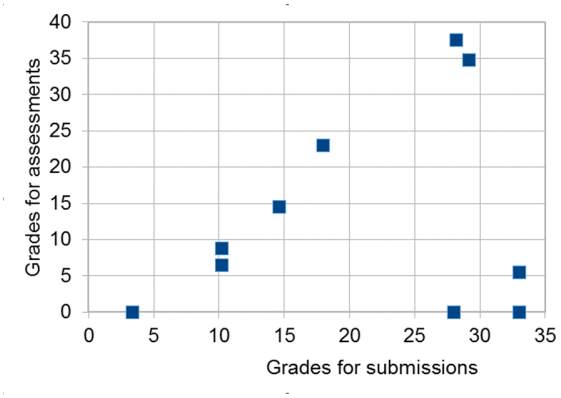

Figure 2: Correlation between students' average grades for assessment and average grades for submitted works (future informatics teachers).

Not all students were able to maintain the proper pace of educational activity progressing from the first topic to the last (figure 3). Some of them worked effective only in the begin, when direct instructions were full enough to execute some tasks. Because of low motivation and lack of elementary skills in self-management, they did not switch to co-management by their own initiative. These students did not submit some works in time and then passed the tasks at classes with personal participation of the teacher in the process of programming and time planning. So we should develop a mechanism for preventive diagnostic of students' skills in self-management and timely turn them to direct management of educational activity. Also, we see that direct management is an easier way of educational activity for some students. This way seems more comfortable for them. So, we should develop special methods to motivate this category of students for their progressing to self-management of the own educational activity. But other students actively used communication and additional sources to solve problems and did not decrease the level of submissions, when progressing to next, more difficult topic.

As expected, the most difficult for the students was the third task in each Workshop, the least difficult – the first task (figure 4). Analysing the structure of student works according to given criteria (figure 4), we can conclude that the most problem for students was not the development of the program but provident that it works correctly. The author's tests often were absent or incorrect. The program, if present, often was correct, but sometimes the reviewer's tests could find some bugs.

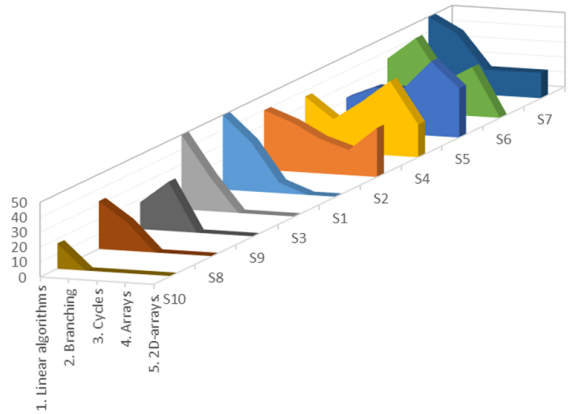

Figure 3: Students' progressing from the first topic task (Linear algorithms) to the last (2D-arrays). Students' names are shown as S1-S10. Vertical axis shows students' grades for submission. The maximum possible grade was 50 (future informatics teachers).

Figure 4: Part of submissions that satisfy to the criterion (program code, author's test, reviewer's test) on each task (first, second, third). This part was calculated as average for all 5 Workshops (future informatics teachers).

The analysis of the structure of students' works showed that the students' competency in introspection was not enough. In our opinion, the introspection is one of the leading elements of self-management competency. So the educational tasks should always content some sub-tasks on introspection.

Summarizing the result of our experience in combining of different types of management of students' educational activity, we can conclude that providing the above pedagogical conditions gave us possibility to improve the educational process in "Practicum of problem solving in informatics". Flexible management of students' educational activity with timely turn from the direct management to co-management and subsidiary management with return, when needed, supported the efficiency learning. In despite students' involving in practical labour out of the educational process, the goals of "Practicum of problem solving

in informatics" were achieved.

4.2 Future Computer Science Bachelors Introspection

According to curricular future computer science bachelors had additional training in programming and their results were higher (see figure 5). Their competence in introspection was enough to produce testing of own programs in comparison with future informatics teachers. But sometimes students did not see the error in these tests. So the grades for auto testing were lower than one for submissions: the program works and processes some data with errors, this errors are shown by author's test, but the author submits this test and does not see the errors. To find errors that were not shown by author's test was more difficult. But reviewers found these errors, so grades for review's tests were less. This situation is well known in practice of software developing. Therefore, introspection is one of the necessary soft competencies in this field of business.

Figure 5: Part of submissions that satisfy to the criterion (program code, author's test, reviewer's test) on each task (first, second, third). This part was calculated as average for all 5 Workshops (future computer science bachelors).

We did not observe a tendency to decreasing students activity and quality of submissions with increasing the difficulty of tasks (see figure 6).

In our opinion, this fact characterises that students of this sample do not need in direct management of their independent work and tried to solve complicated problems. On other hand they, may be, were not so careful with "simple" problems.

Figure 7 shows correlation between students' grades for assessment and submissions. This grades was calculated as average of corresponded grades for all 5 workshops. All grades are shown in relative values, so diapason of values is from 0 to 1.

The above analysis shows that introspection is one

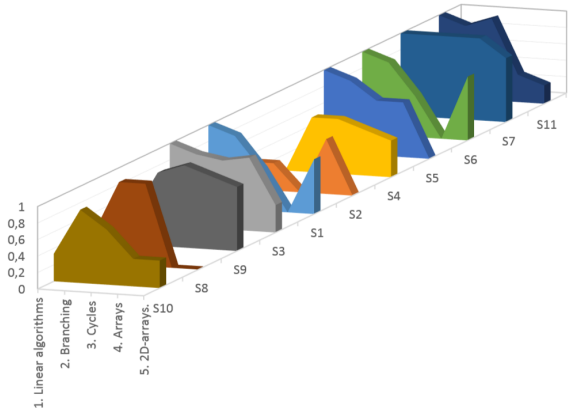

Figure 6: Students' progressing from the first topic task (Linear algorithms) to the last (2D-arrays). Students' names are shown as S1-S11. Vertical axis shows students' grades for submissions. The maximum possible grade was 1.0 (future computer science bachelors).

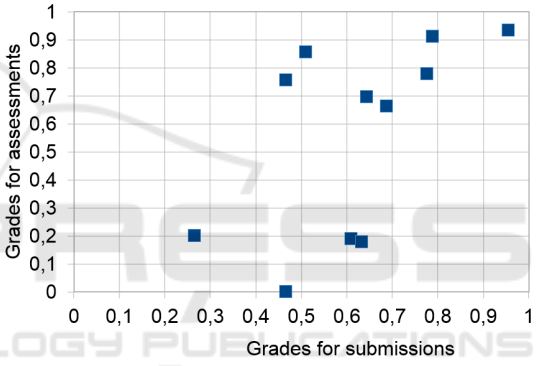

Figure 7: Correlation between students' average grades for assessment and average grades for submitted works (future computer science bachelors).

of the key integral characteristic of the student's learning style. It is important element of pedagogical conditions for high levels of student's independent work management up to self-management. More over, the introspection is a part of professional competences of software engineers. We can see positive correlation between the introspection signs and the signs of problem solving in software developing. Despite satisfactory level of introspection that was observe at our study we should stress that any courseware needs in special tasks for developing and monitoring students' introspection.

We can conclude that the level of students' independent work management was enough high as a result of providing the theoretically grounded pedagogical conditions in in the teaching the course "Algorithms and data structures". Realisation of distant learning components in our courseware gave us possibility for monitoring and timely change the levels

of learning activity management for each student and supported students' self-management when COVID-19 pandemic has influenced on the educational process.

4.3 Correlation Between Introspection and Success in Directly Managed Learning

Direct management of students' educational activity (independent work) was organised at studying new material with Lesson elements of Moodle learning management system. There were suggested 6 such lectures: "Graph processing algorithms (data representation)"; "Graph processing algorithms (data analysis)";"Optimization problems on graphs"; "Basics of tree data structure"; "Application of tree data structure"; "Fundamental algorithms and their construction". This lectures assumed a student to read educational material by short portions and answer corresponding questions online. The lecture work was graded on the base of student's answer correctness. Students attempts to listen the lecture material and answer the question were not limited. The highest grade for answering was used in the course grading system. The time of each attempt was stored. So we have possibility to check was there some correlation between students' results in creative work with their programs developing or testing (high levels of students' independent work management) and results in lecture studying that was managed directly.

Figure 8 shows that correlation between students submissions and their lecture testing result are absent. Direct management provided high level of students' mastering in educational material despite of their results in program developing. Moreover, some students with high mastering in programming did not paid attention enough to obtain the maximum grade for this kind of educational work. We can see similar picture when analysing the correlation between students' grades for assessment and their lecture testing result (figure 9). There are not correlation between students' grades for assessment and the average time that students used to complete lecture with built-in tests also (figure 10). So we can conclude that introspection did not influence at the efficiency of direct managed educational activity.

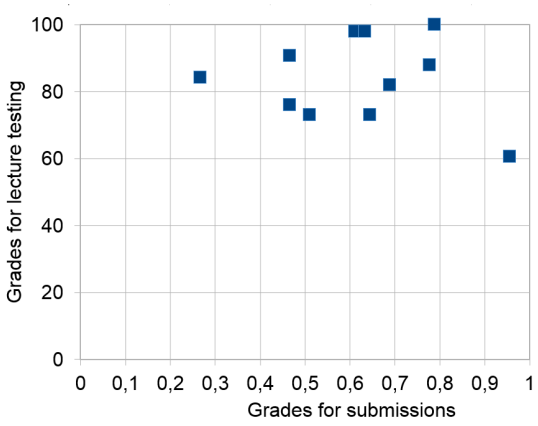

Figure 8: Correlation between students' average grades for submissions and average of the highest grades for lecture testing (future computer science bachelors).

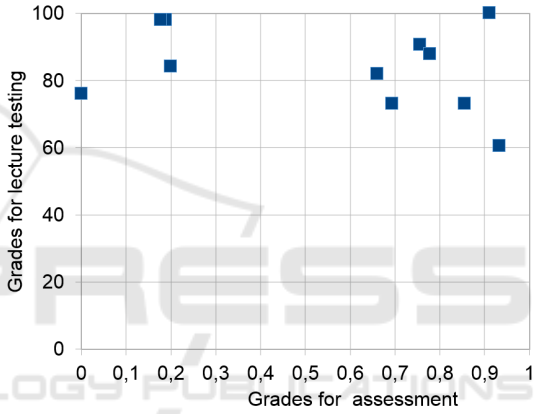

Figure 9: Correlation between students' average grades for assessment and average of the highest grades for lecture testing (future computer science bachelors).

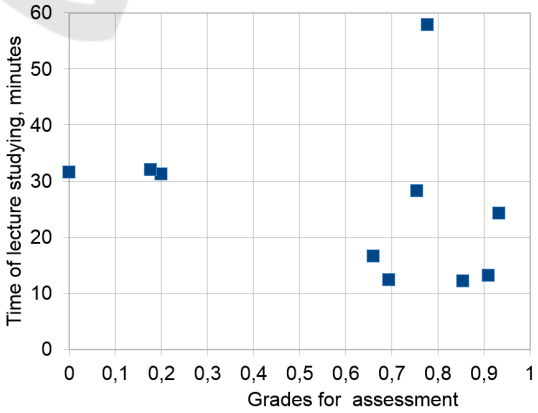

Figure 10: Correlation between students' average grades for assessment and the average time that they used for lecture studying and testing (future computer science bachelors).

5 CONCLUSIONS

Our pedagogical observations during the presented empirical work showed that providing the theoretical grounded pedagogical conditions of management of

student's educational activity led to improving the educational process in the field of programming. We implemented flexible management of student's educational activity with timely turn from the direct management to co-management and subsidiary management. We observed that such methods supported the efficiency of learning.

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

- signs for student's introspection as a characteristic of his/her learning activity was suggested: 1) student's success in testing there own programs; 2) student's success in testing and evaluation of the program code of other participants of the educational process – our pedagogical observations showed that introspection measured by this way positively influenced to students self-management efficiency;
- students' competency in introspection is important as for self-management of their independent work as for solving practical tasks in the field of programming, so it should be improved, and educational tasks should always content some subtasks on introspection;
- some students are not ready to manage their own learning activity, sometimes the type of management of student's educational activity should be timely turned back to direct management – using direct management of learning activity for students with low competence in introspection gave them possibility to master the educational material;
- students' introspection did not influence on efficiency of their learning activity under direct management; more over, some students with high level of introspection did not carry out the tasks under direct management enough carefully; so the improving management of students' independent work from direct management through co-management and subsidiary management to self-management is the important task of educational process.

Further work in the field of computer-oriented management of students' independent educational activity we see in developing new methods of students' progress from direct management through co-management and subsidiary management to self-management in information and communication educational environments, in introduction of these methods into various educational disciplines as well as studying pedagogical and psychological conditions to increase students' motivation for self-management of own educational activity.

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