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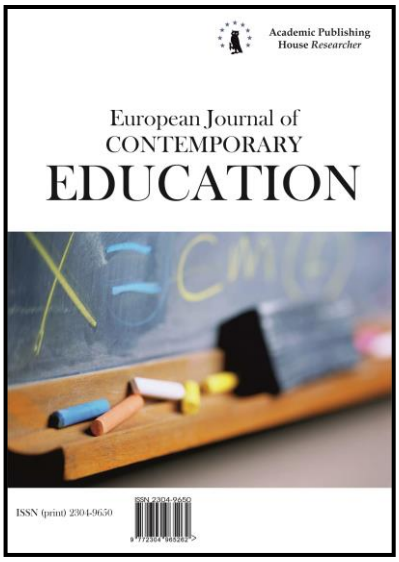

A Study Module in the Logical Structure of Cognitive Process in the Context of Variable-Based Blended Learning

Galina I. Smirnova [a, *], Valery G. Katashev [b]

[a] Volga State University of Technology, Russian Federation
[b] Kazan Federal University, Institute of Pedagogy and Psychology, Russian Federation

Abstract

Blended learning is increasingly gaining importance in all levels of educational system, particularly in tertiary education. In engineering profiles the core blended learning activity is students' independent work, the efficiency of which is defined by the degree of students' active involvement into the educational process, their ability to absorb new knowledge independently, on their own. Our research is aimed at the analysis of blended learning and at revealing the approaches meant to activate students' independent work in blended learning based on LMS Moodle platform. The characteristic feature of the suggested approach is the orientation towards skills and work methods mastering carried out in the form of professional competencies training at practical classes and laboratory workshops. For the purpose of our research we used one of the most interactive Moodle tools – "workshop" in order to fulfill informational, educational and monitoring functions of learning. The use of the tool allowed revealing drawbacks of the method under study and managing these drawbacks in the most effective way. The paper contains the description of students' learning and independent work which would stimulate students' activity, self-management and develop their communicative skills.

The outcomes of the current research proved that the approaches suggested significantly stir students' interest, thus, enhancing students their learning motivation, development of critical thinking and self-reflection, which altogether facilitate understanding theoretical material, encourage the development of practical skills and promote the pursue of academic goals.

Keywords: LMS Moodle, engineering education, cognitive activity and independent work.

* Corresponding author
E-mail addresses: SmirnovaGI@volgatech.net (G.I. Smirnova), vgkatashev@gmail.com (V.G. Katashev)

1. Introduction

The gap arising due to continuous reduction in the number of face-to-face classroom hours in compliance with the Federal State Educational Standards of Higher Professional Education is complemented with e-learning. Based on the existing experience, pure e-learning is practically applicable in distant learning or advanced training courses, where learners are ready for subject teaching.

In full time engineering education, which also integrates e-learning, the focus shifts towards students' independent work. However, this reveals a didactic contradiction: the learning environment requires the adequate students' readiness for the cognitive activity, while eclectic mix of conventional and e-learning and teaching results in the drop of motivation and misunderstanding of learning goals.

Information technologies are widely introduced into the process of learning and teaching; they intensify the process of professional competencies acquisition on condition that instructional techniques are didactically practised at every stage of a student's cognitive activity.

The development of higher education didactics in the context of e-learning tools preconditioned the emergence of blended learning. However, the name doesn't capture the idea of the learning process. Blended learning generally combines conventional academic and distant interactive e-learning. In blended learning the classroom and distant learning methods are methodically balanced (Skokova, Dambueva, 2013). Under this type of instruction students mainly work independently, on their own, thus, developing their cognitive activity, motivation, self-education, information search in the media based on psychological regularities of the process of any learning material acquisition.

The publications concerning blended learning in technical educational institutions focus on the design of educational process in the context of a three-phase structure of the cognitive process (Veledinskaya, Dorofeeva, 2014; Ivshina, 2012).

The first phase precedes the classroom activity and implies preparation based on the learned material and the background knowledge. The second phase or classroom phase includes face-to-face collaboration between a teacher and students. During this phase students acquire some new material. The third phase or post-classroom phase includes students' independent work aimed at further mastering of the learned material, which allows individualizing the process of education (Veledinskaya, Dorofeeva, 2014; Kravchenko, 2014; Nikitina, 2014).

The issues concerning students' independent work in the format and amount suggested in the context of blended learning are merely mentioned.

In order to organize students' independent work it is necessary to develop didactic rationale and methodological recommendations of the cognitive activity under study. Therefore, it is rather urgent nowadays to analyze students' independent work in blended learning and to develop the logical structure of students' cognitive activity arrangement in combined forms of education.

Full time education in technical educational institutions is mainly carried out on virtual learning management system (LMS) Moodle (Modular Object-Oriented Dynamic Learning Environment). Nozawa argues that this environment is potentially strong for establishing and developing professional competencies (Nozawa, 2011).

In technical majors students develop professional competencies mainly during practical classes and laboratory workshops. Thus, these forms of educational activities require didactically tested methods of students' independent work.

Our research of blended learning is aimed at revealing the approaches of intensification of students' independent work carried out on LMS Moodle platform. In order to achieve the set goal the following sub-goals should be consequently attained:

– to define the reasons for students' low activity in blended learning practical classes and laboratory workshops and suggest optimum didactic approaches that would bridge these contradictions;

– to implement the suggested solutions aimed at students' independent work intensification on LMS Moodle platform.

2. Materials and methods

Blended learning is based on the traditional "brick and mortar" education. It integrates the digitized learning contents into traditional education and makes good use of the Internet with all the opportunities it has to offer. In this form of education the gravity center of learning shifts towards students' independent work, in which psychological regularities of learning material acquisition are not taken into account.

Without understanding the point of the learning material or cause and effect relationships of certain physical phenomena within the syllabus a student gets lost and finds him/herself caught in the logical stopper, which inevitably results in the loss of interest to the subject and learning in general. In this case the motivation of proficiency development is extremely low.

By the unstructured application of didactic principles of traditional and e-learning as if to be based on competence, practice-oriented and subject approaches a student gets into a didactic deadlock.

First of all, a student in this particular situation is not a subject of education. Secondly, the training process or skills development should follow understanding and professional activities mastering, therefore the research into the process of students' learning structuring when they master professional skills implies the use of reproductive and active methods in every module.

Fundamentally every module is characterized by the learning material availability, practical drilling, followed by the case study analysis, students' collaborative interactive group work, critical peer evaluation of attained learning outcomes and competence development. The module efficiency is evaluated based on the comparative analysis of the level of professional competencies gained in the process of learning on the one hand and programme requirements and general statistical analysis on the other.

The source material for the current research was the real practice of a higher educational institution, experience of students independent work (Ivshina, 2012; Valedinskaya, 2014; Semenova, 2014), characteristic features of students' independent work in the process of gaining professional competencies (Skokova, Dambueva, 2013), validity of student peer evaluation (Swan et al., 2006).

3. Discussion

The problem of making students' independent work dominant in the cognitive activity is the core problem in contemporary didactics. Availability of e-resources and digitized learning materials as novel educational medium facilitates students' involvement when mastering professional competencies. On the one hand, it is very convenient, on the other, it significantly intensifies the process of general and professional competencies mastering. Some scientists report on the experiment of students' independent work beyond the in-class learning (Valedinskaya, 2014; Semenova, 2014).

During the phase preceding the classroom time students are asked to study the topic on their own and do a problem solving task , e.g. an essay followed with a test.

The approach was called the "method of flipped class" (Veledinskaya, Dorofeeva, 2014). This approach is well applicable to humanitarian disciplines. However, it proved not to be so efficient for engineering disciplines, particularly during the first or the second year of the bachelor course due to the complexity of the learning material, which requires the presence of a teacher or a tutor in the learning process. Otherwise students lose interest to the material under study, fail to cope with the assignments, which results in unsatisfactory quality of education.

When students work independently on problem based assignments, they need to operate their background knowledge, be persistent and capable to work continuously on a problem.

It is very typical for contemporary students, brought up in the information space environment, to have discrete thinking, which generally means that information is perceived in unrelated pieces. This type of thinking makes students incapable of analytical thinking (Smirnova, Katashev, 2013).

To make things still worse, as a rule students do their independent assignments right before the due date. Therefore, in most cases they either don't do the assignment properly or merely fail it, which prolongs the term of learning.

Playing computer games for long hours every day results in low creative and analytical thinking and long-term memory. As a result students are lacking self-analysis skills, are not

capable to work on the assignments independently and demonstrate low interest to their professional activity.

Thus, students should develop thinking, motivation and abilities to work on their own in the process of learning (Smirnova, Katashev, 2013). Motivation is one of the most important components of distant learning efficiency (Blázquez, Alonso, 2009). Students' active involvement in the learning process fosters the development of students' independent work and motivation.

Thus, when organizing students' independent work in blended learning it is recommended to concentrate on activation of learning and cognitive students' activity under variable structuring, logically relevant learning and cognitive process.

4. Results

Blended learning, being a didactically non-tested method in the framework of competence-based approach, employs the interactive model of learning. Ideally, within this model a teacher acts as a consultant. However, in reality students need explanation of the competence core. A student is perceived as a subject of education, actively acquiring new knowledge and applying this knowledge in practice. But in fact students are unable to make sense of the core of the subject, the more so, when it comes to its mathematical interpretation. Thus, this model intensifies the role of instructional design meant to prepare students for independent work based on his/her personal cognitive qualities.

Technical students' independent work is mainly aimed at enhanced learning of theoretical technical material; reinforced mastering of skills and methods acquired during practical training and laboratory workshops, i.e. all types of activities which develop the necessary competencies. In order to design these kinds of classes didactically balanced in terms of classroom and independent students' work the following conditions should be met:

– quality educational-methodological material and technical resources including text-books, students' guide-books, computer classrooms, contemporary equipment;
– regular teacher-student face-to-face tutoring organized according to timetable within a student's independent work;
– regular monitoring of students' progress in competencies mastering.

However, these components alone are not sufficient for organizing quality independent work of students, which becomes efficient only on condition that students demonstrate active cognition stirred by real learning motives.

The LMS Moodle platform stimulating students' activity via teacher-student or student-student communication. The work mode "student-group" is also gaining in popularity. The platform features a number of other handy didactic tools aimed at activation of students' cognition: forums, individual assignments, workshops, surveys, chats, wiki, etc. (Gilmutdinov et al., 2008). The most interactive type of learning activity for practical or laboratory classes is the "workshop".

Blended learning integrates electronic and traditional learning and results in the change of informational, educational and controlling functions of a learning process (control and self-control) (Ivshina, 2012; Kravchenko, 2014; Nikitina, 2012; Gilmutdinov et al., 2008; Arkhangelskiy, 1980; Kravets, 2012; Petruk, Popolzina, 2013), therefore, we will focus on students' activity when implementing these functions.

Informational function is fulfilled when the information is presented to students in the digital form in hypertext representation or e-publications. It allows a significant increase of the amount of information, facilitation of its availability and providing an opportunity to observe the visible model of a physical process.

The educational function of an interactive educational medium is implemented when mastering theoretical material and developing practical professional competencies in training sessions of different complexity levels. In order to achieve the set learning outcomes it is necessary to follow a certain algorithm of activities, learning patterns and variability of training programmes.

The controlling function is bound to provide accuracy and consistency of the skills mastered as well as leave room for the correction of these skills, if the necessity arises.

The research into the "workshop" tool proved the presence of every function mentioned above. They are distributed in different consequently emerging temporal stages: setting phase;

work presentation phase; self-evaluation phase; peer-evaluation phase, teacher evaluation phase, workshop closing phase.

The informational function is implemented during the first introductory phase when the students are instructed on how to deal with the assignment based on the learning pattern and evaluation form.

The educational function is implemented during the work presentation phase and evaluation phase. In this phase students do their assignments and attach them in e-form to the workshop. The tool is convenient from the point that students get a chance to do peer evaluation as well. In addition to working on their own they may benefit from analyzing and critically thinking on the works of their peers, thus, they undergo a double training. After this phase completion, students get feedback from the teacher, who may comment on a students' assessment grade and explain why the work was graded in that particular way. This phase facilitates further competence mastering. The learning process in this respect is similar to self-evaluation or peer-evaluation. Therefore, it contains evaluation instruction, the method of works distribution among students for evaluation and the due term. The number of works for peer-reviewing process may be undefined, however in order to develop solid skills students should evaluate at least 4 works of their peers.

In addition to LMS Moodle the efficiency of training may be enhanced by employing computer simulators of physical processes, laboratory works with the use of virtual apparatus, developed in specialized software environments, like LabView (Proshin, 2012).

The controlling function is represented in the phase of work submission, peer and teacher evaluation. Within this phase the competencies developed may undergo certain corrections. In this phase there is a final summarizing of the learning material acquisition, reflected in points. The final grade gained for the laboratory (practical) assignment within the "workshop" tool is the combination of two components: the work itself and the assessment process. It can be characterized by flexibility due to applied weighing coefficients.

If a student had the assignment done and the submitted e-version deserves the highest possible grade, the teacher may check whether his skills were developed after the 3–4 peer review analyses. If a student misses typical mistakes due to lack of knowledge and graded his peers with excellent marks only for conflict avoidance, the teacher in his/her final evaluation may correct the peer evaluation component. Thus, the final grade is bound to be more valid.

The practice of the "workshop" tool application allowed to revel the following weak points of its use:

1. Inherently subjective character of peer evaluation;
2. Reluctance of some students to evaluate the works of their peers;
3. Students' cheating when submitting their works in distant e-form without getting into the heart of the matter.

We will consider the possible ways of these drawbacks elimination. The ways to eliminate these drawbacks are systematized in Table 1.

Table 1. Drawbacks of the "Workshop" Moodle tool and ways of their elimination

Problem	Reason	Solution
1. The subjective character of peer evaluation.	a) Misunderstanding of the approach to the assignment.	The first laboratory (practical) work must be graded by the teacher. This work refreshes students' knowledge and demonstrates the practical value of the work being done, as well as highlights the typical mistakes.
	b) Inability to grade the work of their peers fairly.	The defense of the second laboratory (practical work) should be organized in pairs or small groups, supervised by the teacher. At this stage students master elementary evaluation skills.

1. Reluctance of some students to evaluate the works of their peers.	a) Fear of spoiling friendly relations. b) Fear of a primitive evaluation.	The flexible set of integral grade components: grading the work being done and the evaluation process itself.
2. Cheating of some students when submitting their works in distant e-form.	Misunderstanding and fast submission of the assignment.	Increase in the number of peer-reviewed works and the increased weight of such evaluation.

In order to define the reasons for the first shortcoming we used such research methods as observation, discussion and survey which allowed revealing the two main reasons of their emergence:

– misunderstanding of the subject matter which results in misunderstanding of the solution method;

– incapability of students to provide an objective assessment of the work.

The first shortcoming is of objective character, since a student immerses him/herself into a new subject field. It is time and effort consuming for students to master the methodology and algorithm of solving practical tasks without a tutor's guidance.

At this stage the teacher's assistance is quite necessary. Therefore, the first laboratory and practical assignments should be submitted to a tutor. Grading a student for the submitted assignment in this case is not enough. The teacher should refresh students' knowledge, demonstrate the practical value of the work carried out and highlight the typical mistakes.

The analysis and evaluation of a second laboratory or practical work is carried out in peer-review mode under the tutor's supervision (Swan et al., 2006). In this case a student acquires the basic assessment skills. Through the process of communication students develop their communicative and critical thinking skills. Thus, the second problem is eliminated, i.e. students learn to grade their peers in the objective way.

Rather often students are reluctant to grade their peers objectively for fear of hurting their peers' feelings. They can give marks without checking their peers' works and grade all the works either average or high. In order to manage this problem we suggest a flexible combination of points awarded for both, the work and the assessment itself. This is available on the Moodle platform.

Peer evaluation is highly criticized in literature, in terms of its validity (Wilson et al., 2015). In fact, it is really doubtful to trust peer review if the procedure is sporadic and isolated. The validity is achieved by multiple application of the approach supervised and guided by the teacher when evaluating a number of works by various students for the purpose of training. In this case a student's knowledge and skills are revealed. They are highlighted and evaluated as extra points. By doing so we can stimulate the manifestation of a student-evaluator's skills and knowledge through extra grades. This grading has a different weighing coefficient as compared to the grades awarded for the work carried out. Thus, a peer review corresponds to the didactic principle of multiple revision of a learning material which optimizes its mastering.

The third shortcoming emerging as a result of students' cheating when presenting their work in e-form is not widespread, but even on rare occurrence, it can't be ignored. One of the most efficient solutions for this problem in the extension of the number of peer-reviewed works.

For the purpose of evaluating the efficiency of the suggested approach we carried out an experiment at the premises of Volga State University of Technology. Two groups of students from engineering majors "Biotechnical Systems and Technologies" and "Radio-Technical Systems and Complexes" participated in the experiment. The experiment in these two groups was carried out within the following courses of study: "Biotechnical System Management" and "Radio Automation Engineering" correspondingly. The experiment lasted for 2 years from 2014 to 2016 and involved 75 participants. All the students were divided into two groups: a reference group and an experimental group.

Based on the assumption that the development of effective independence and learning motivation are defined by the students' active position, we used the following criteria, meant to evaluate the validity of approach:

– assignment due date;

– degree of assignment completeness.

In the framework of our experiment these criteria were set as follows: the due date was set in compliance with the academic calendar, the assignment submitted should be completely accomplished. The results of the experiment are tabulated in Table 2-3 and Figure. Task specific table columns contain a number of students who submitted the completed task by the due date. We define them as effective students. The table line "Total (%)" defines the percentage of effective students as related to the total number of students.

Table 2-3. Number of students submitted assignments by the due date

Reference group

Major	**Number of students**	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**	**Task 7**
Major 1*	13	2	1	3	3	5	7	8
Major 2**	13	3	4	5	4	6	7	7
Total number	**26**	**5**	**5**	**8**	**7**	**11**	**14**	**15**
Total (%)		**19.23**	**19.23**	**30.77**	**26.92**	**42,31**	**53.85**	**57.69**

Experimental group

Major	**Number of students**	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**	**Task 7**
Major 1*	26	6	5	7	13	16	20	24
Major 2**	23	7	5	9	12	17	19	19
Total number	**49**	**13**	**10**	**16**	**25**	**33**	**39**	**43**
Total (%)		**26.53**	**20.41**	**32.65**	**51.02**	**67.35**	**79.59**	**87.76**
Efficiency		**7.30**	**1.18**	**1.88**	**24.10**	**25.04**	**25.75**	**30.06**

*Major 1 – Biotechnical Systems and Technologies
**Major 2 – Radio Engineering Systems and Complexes

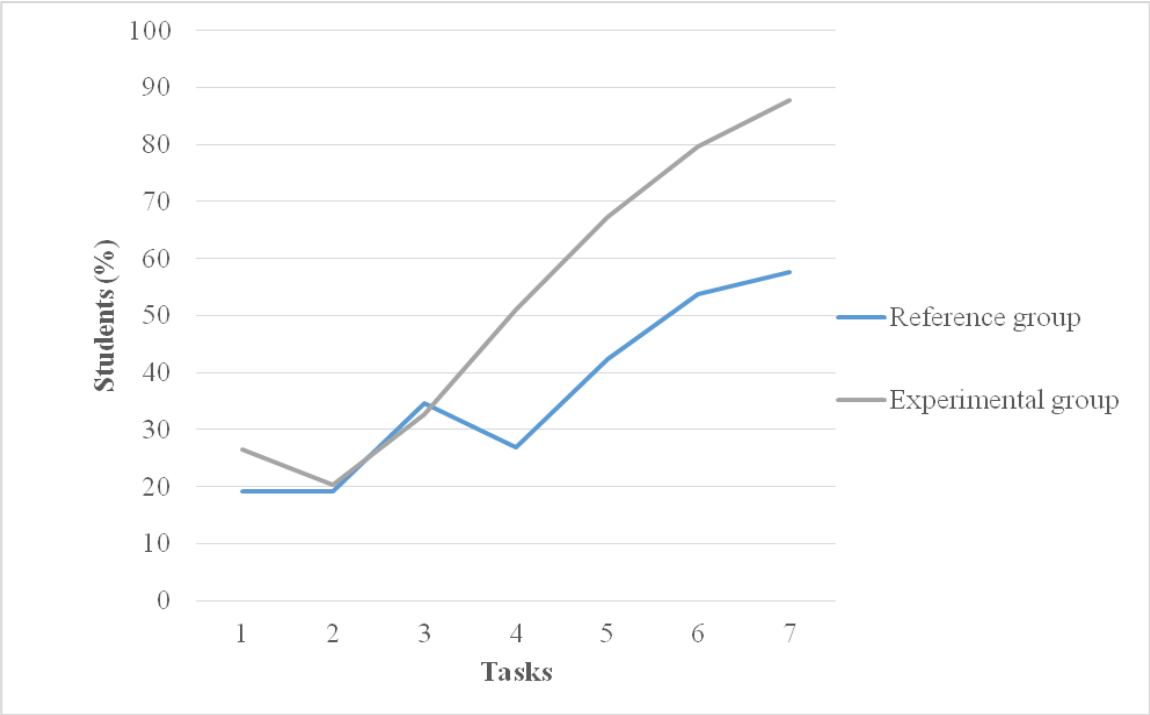

Fig. Efficiency of task fulfilment

The efficiency of the approach was calculated as the difference in the number of effective students in the reference and experimental groups.

As it can be seen from the Figure above, the number of effective students increases from 51 % to 81 % in tasks 4–7. The method efficiency is 30 %.

Upon the experiment completion the participating students were surveyed, and the survey revealed the significant development of the following aspects:

- critical thinking of the learning outcomes and transparency of the grades awarded;
- self-evaluation and peer evaluation skills;
- communicative skills, since the work is carried out in collaboration.

5. Conclusion

The suggested didactic method aimed at the activation of students' independent work was applied in student groups majoring in "Biotechnical Systems and Technologies", and "Radio Engineering Systems and Complexes" included into the Federal State Educational Standard of Higher Professional Education in the Russian Federation. The method was used within the study courses: "Radio-Automation Engineering" and "Biotechnical System Management". As a result, the variable-based structuring of the study material based on regularities of human cognition with the use of "workshop" interactive tool made it possible to significantly intensify the efficiency of cognition in the context of blended learning.

The tendency manifested itself in the noticeable increase in the results of students' independent work. About 90 % of students submitted their assignments by the due date under fixed deadlines, grading transparency, critical analysis of typical and non-standard professional case-studies.

Participating students developed their communicative and reflexive skills due to active involvement in self-evaluation and peer evaluation procedures.

The participating students demonstrated increase in their learning and cognitive activities due to the flexible set of integral mark components: grades awarded for the work, grades awarded for the assessment of work and increase in the number of peer-evaluated works.

Thus, we argue that the learning and cognitive activity was intensified in students' independent work at laboratory and practical classes with the consequent reporting.

The novelty of the current research is as follows:

1. The research provides a didactic rationale for the learning module design within the logical structure of the cognitive process under variable-based combination of classes in blended learning.

2. The authors present a variable algorithm of workshop structuring as a tool for stimulation of students' cognitive activity in the framework of their active independent work.

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