Integrative Assessment Framework in Blended Learning

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Abstract **– Development of blended learning leads to reconceptualization of teaching methods, transformation of assessment tools and frameworks. This paper proves the relevance of the integrative assessment frameworks regarding blended learning environments. The authors introduce the original framework combining both formative and summative assessment perspectives. During the experimental implementation, this framework, based on the modified project management earned value method, demonstrated its effectiveness and appropriateness to blended learning programs.**

Keywords **– blended learning, formative assessment, summative assessment, integrative assessment framework, earned value method.**

1. Introduction

The advances in information and communication technologies have led to the development of wide spectrum including new techniques, methods and models of education. One of the promising approaches with reference to the implementation of the digital technologies in education is blended learning.

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Not only teaching and learning methods, but also tools and techniques of assessment are going through the process of rethinking and reconceptualization. Computer-mediated educational methods provide the opportunity to collect abundant information concerning many different aspects of learning experience. Blended learning designs can improve learning attainment and effectiveness by giving informative and motivating feedback to students, teachers and course designers, using consistent and transparent assessment frameworks.

This article introduces the original framework of formative and summative evaluation adopted from the project management practices, and adapted to the aims of blended learning. Firstly, the paper analyzes the current research trends in the blended learning. Secondly, applying such formal tools as network models and heat map diagrams, the authors investigate the topics of the most research interest in blended learning, and come to the conclusion that both formative and summative assessment issues occupy an important place in the blended learning research agenda. However, the interest of formative assessment is notably higher than summative evaluation. Thirdly, the article overviews the relevant theoretical aspects regarding formative and summative assessment in blended learning. The authors formulate the concept of integrative assessment framework, which combines formative and summative perspectives of assessment in the blended learning context. Fourthly, the authors introduce key learning indicators based on the earned value method, which is widely used in project management theory and practice. The authors explain calculation and interpretations of the key indicators and show the examples of their practical use. In the fifth part of the article, the results of experimental implementation of the framework are presented. The introduction of the framework in a Russian private university, specialized in the online and blended learning, improved learners', teachers' and course designers' abilities to monitor learning experience and to adapt learning materials and strategies to the scope of disciplines. The increase in students'

engagement and time-management skills was also discovered. The results of the practical implementation allow the author to conclude that the integrative assessment framework introduced in this paper is characterized by the appropriateness for blended learning programs and the potential effectiveness.

2. Blended learning as an area of research

According to Bonk and Graham [1] blended learning ('hybrid learning', 'technology-mediated instruction', 'web-enhanced instruction' and other terms are also used as interchangeable notions) should be understood as the integration of traditional classroom forms and techniques with methods and models based on the implementation of digital technologies. Garrison and Vaughan [2] underlined that blended learning should not be understood as a mere introduction of computer-based methods into classic forms of education. They emphasized that blended learning is such a combination of traditional and new methods of education, which leads to the enhancement of learning experience by increasing students' engagement and improving the efficiency of learning.

There is a consensus among majority of theorists and practitioners that blended learning includes not only digitally mediated methods, offline or online, but also new non-computer educational tools and techniques [3]. These include flipped classroom [4], gamification [5], personalized learning [6], and peer learning [7], all of which can be implemented with or without ICT support.

Blended learning is being widely implemented in elementary schools, universities, corporations, and public sector [1]. The interest in blended learning among researchers, teachers, trainers, and managers is constantly increasing. The number of articles has been skyrocketed in the recent five years. The number of Scopus-indexed publications is illustrated in Figure 1. The curve depicts the number of documents retrieved with the query on 'blended learning' in keywords of articles.

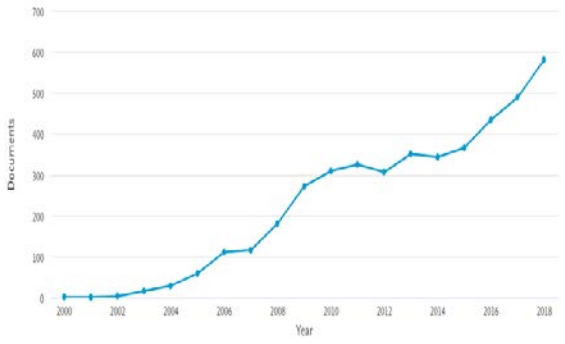

Figure 1. Number of documents in Scopus devoted to blended learning

Industrially advanced countries, such as USA, UK, Australia, Germany, Canada, and Japan, as well as some developing countries, such as China, Taiwan, and Malaysia, demonstrate the greatest research interest regarding blended learning. In comparison to the 10 most active countries, the research activities in Russia and other Slavic countries, including Serbia, seem to be quite modest, as it is demonstrated in Figure 2.

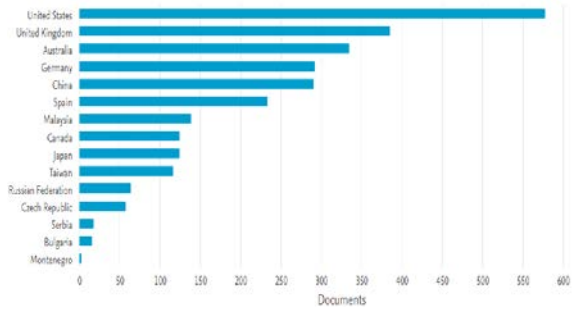

Figure 2. Distribution of scientific papers on blended learning by countries

Overall, the research in blended learning has been booming, which reflects the rapid development of new practices in this field. However, different topics in blended learning research are characterized by the different degree of relevance and interest for theory and practice.

3. Research agenda in blended learning

Blended learning has become an established and quite complicated area of research, in which the most relevant topics concern assessment and evaluation aspects. Figure 3 shows the heatmap of the most relevant concepts discovered in the current research concerning blended learning. The map was built of the keywords from the 2000 most cited papers on blended learning retrieved from Scopus. Drawn with the help of VOSviewer software, Figure 3 shows the frequency of the terms (depicted with the intensity of colors), and their simultaneous presence in the articles (demonstrated by the spatial vicinity on the diagram). The keyword 'blended learning' was excluded. The map reflects the 46 most frequently used terms (60% of all words).

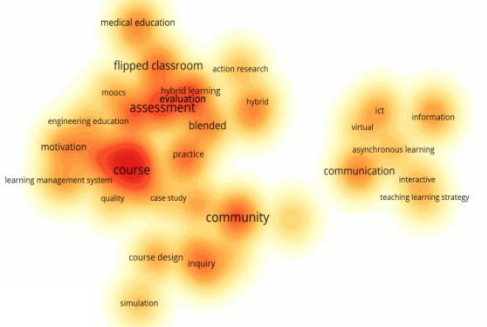

Figure 3. Number of documents in Scopus devoted to blended learning

The algorithms of VOSviewer take into account the frequency of the separate words mentioned in articles' keywords and their co-presence papers. The more words co-appear in papers the closer they are in the map. If a word occurs frequently, but with different collocated companion-words, it is depicted in the map as a separate unit. For instance, in Figure 3 there is a concept of 'blended'. That means that in the field of blended learning there are many keywords which include 'blended' ('blended instruction', 'blended communities', 'blended synchronous learning', 'blended classroom' and so on), but there are many different combinations with 'blended' each of which appears not very frequently. However 'blended', individually, is often used .

Figure 3 shows that 'assessment' and 'evaluation' form one of the clusters identified in the word network model constructed with the same set of keywords from the 2000 most cited articles on blended learning.

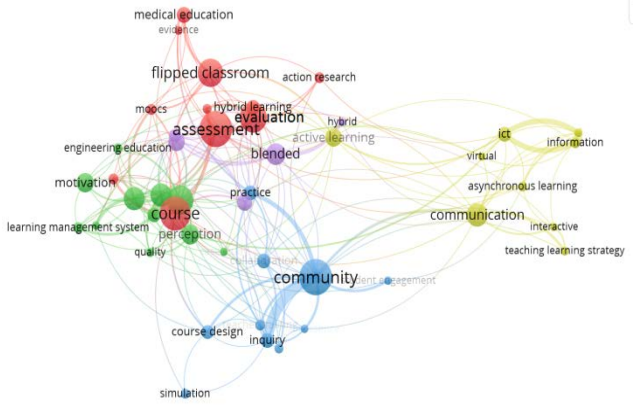

Figure 4. Word network model of keywords in the most cited paper on blended learning

'Assessment' and 'evaluation' are not only among the most popular topics, but also closely intertwine with other concepts. The position of these terms in the word network model, provided in Figure 4, proves their importance regarding the current research in blended learning.

Deeper analysis of the keywords comprising 'assessment' shows that among researchers there is significant interest in formative assessment issues, which is demonstrated in Figure 5. There is also a number of concern for instructional assessment, which is close to formative assessment.

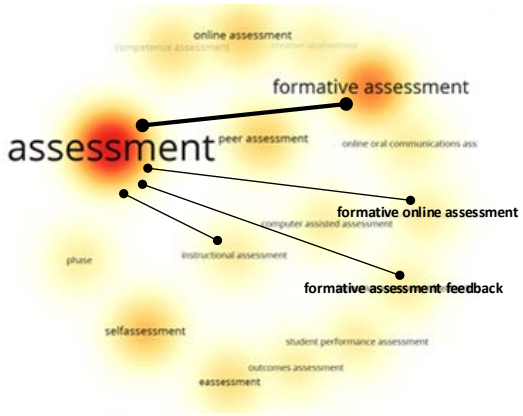

Figure 5. Heat map of terms used in keywords including 'assessment'

Figure 5 was drawn on the basis of the same set of the 2000 most cited papers. However, in this case we analyzed the keywords that imply 'assessment'.

The same technique was applied to 'evaluation'. The resulting heat map is presented in Figure 6.

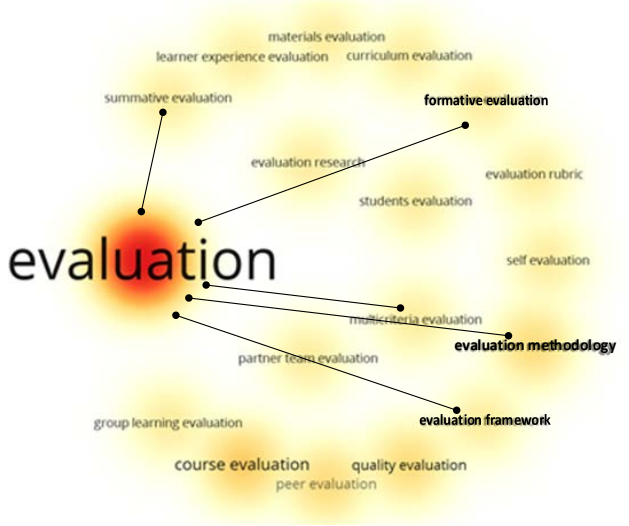

Figure 6. Heat map of terms used in keywords including 'evaluation'

Figure 6 reveals the observable interest in formative and summative evaluation, multicriteria evaluation, evaluation frameworks and methodologies.

Summarizing observations from the formal investigation of the most popular keywords related to blended learning, we conclude that the development of formative and summative assessment tools occupy notable place in the current research landscape. The researchers are striving to elaborate not just sets of different evaluation metrics, methods and tools, but, first of all, consistent multicriteria assessment frameworks combining formative as well as summative perspectives.

4. Formative and summative assessment in blended learning

Assessment is an intrinsic element, which is included in all educational processes. There is generally accepted difference between formative and summative assessment. The primary goal of formative assessment is to monitor students' learning experience in order to improve accomplishment of learning objectives and to enhance learning efficiency [8]. Summative assessment procedures intend to evaluate, in the first place, knowledge gained, competences developed, and skills improved as a result of learning objectives achievement [9]. Comparing summative and formative assessment William [9] came to the conclusion that it is the formative assessment that really helps learners and teachers to improve the learning processes, while summative assessment is mainly associated with final grades, which can have the adverse impact on learning.

Blended learning provides all stakeholders of the learning process with abundant data concerning many aspects of students' experience. That is why formative assessment frameworks are flourishing along with the advances of blended learning [10].Besides providing the data relevant to learning progress, formative evaluation has a motivating impact on learners, stimulating them to adapt their learning strategies to the specificities of materials and to improve their learning skills [11].

However, despite the prevalence of and interest to formative assessment, we should not disregard the necessity of the traditional, more formal summative indicators. By combining both summative and formative perspectives in a consistent system of learning parameters, we can alleviate the limitation of summative assessment tools. Hence, the concept of integrative assessment framework is becoming quite relevant to the further development of blended learning.

5. Integrative assessment framework and examples of its practical use in blended learning context

Despite the fact that education can be characterized as a process-oriented activity, we can also consider it as a project-based practice. All educational activities have objectives that should be achieved within the limited period of time and predefined budget. Education implies the implementation of competences from different areas and disciplines, and it can be considered as a cross-functional endeavor. Hence, to some extent, we can draw an analogy between educational and project-based activities. Building on this analogy, we can transplant project control tools and techniques to the area of blended learning and adapt them to the needs of integrative assessment.

One of widely used and universally accepted techniques regarding the project control is earned value method. It is based on three intuitively clear parameters (Planned Value, Earned Value and Actual Cost), helps to monitor and analyze time and budget performance of projects [12].

Transforming the project earned value method into the blended learning assessment framework, we introduce three parameters – Planning learning, Earned learning and Actual learning. These help to assess both learning results and learning productivity, and provide informative and motivating feedback to leaners, teachers and course designers.

In our framework, Planned learning (PL) is a numerical measure of the learning results expressed as a standard (normative) number of hours that a student should spend in order to fully achieve the learning objectives. For example, students have to study 10 topics. which is equivalent to 100 hours of study. The full achievement of all learning objectives in 10 units means that a student earns 100 learning points. In this case, PL is 100.

If a student demonstrates only a partial number of necessary competences, he or she earns only some part of 100 learning points. For instance, the student's grades within a course demonstrate that he or she gets 80% from the maximum available mark. That means that the student's Earned learning (EL) is 80 learning points. The variance between PL and EL shows the 'volume' of knowledge that was planned to be acquired but has not been acquired by the student. This variance can be called Learning Results Variance (LRV). It shows the difference between the planned learning results and achieved ones.

Computer-aided educational techniques used in blended learning environments help to measure actual time spent on study of a subject. For example, we know from attendance system that the student participated in classes for 20 hours and spent 40 hours of active learning on-line. In this case, his or her Actual learning (AL) is equal to 60 learning points. The variance between EL and AL can be understood as a learning productivity measure and called Learning Productivity Variance (LPV). In our example, the student receives 80 learning points, but actually 'spent' 60 points. He or she 'saved' 20 learning points, which in this case means 20 learning hours 'economized' by the student. The student studied more efficiently than it was planned for an average student with the similar attainment of learning objectives. However, he or she has not achieved the maximum value from his or her learning (LRV is only 80 learning points).

Measuring AL and LPV for different students, the teacher can identify learners who struggle with the material and need additional help. The teacher can identify the number of learning points for each unit of the subject, and analyze which unit is more difficult for students, and why students spend less time on learning than it was planned. If we distribute the learning points along the timeline of the course, we provide the opportunity for the teacher and students to track their learning results and productivity along the course schedule.

In Figure 7 there are exemplary S-curves for PL, EL, and AL. The horizontal axis is a timeline along which we schedule the key stages of the course. The vertical axis shows learning points.

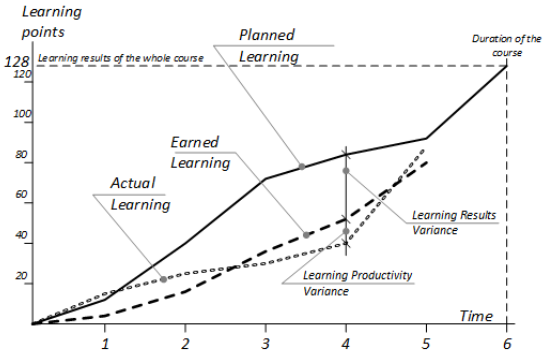

Figure 7. Exemplary S-curves for Planned Learning, Earned Learning, and Actual Learning indicators

The whole course was scheduled to be completed in 6 weeks and the overall amount of study time was planned as 128 hours, which was equaled to 128 learning points. All learning points were assigned to the weekly stages. The learning results were assessed at the end of each week. Planned Learning S-curve shows the cumulative planned learning results of the course. Similarly, Earned Learning S-curve reflects the factual learning results measured in learning points. From Figure 7 we see that a student, during 5 weeks of study, was regularly receiving grades lower than maximum. Earned Learning curve lies below Planned Learning curve. LRV calculated as EL minus PL is negative at all weekly stages. Actual Learning S-curve lies above Earned Learning curve in weeks 1 and 2,which means that at these stages the student spent more study hours than it was expected by the course structure. LPV calculated as EL minus AL is negative, which means that the student's learning productivity was lower than expected. However, in weeks 3 and 4 the student improved his or her productivity which is reflected by the fact that Earned Learning curve is above Actual Learning curve. Unfortunately, in week 5 the learner decreased his or her learning productivity again.

In Table 1 we provide the quantitative data for the example in Figure 7. Table 1 shows all calculations that needed to apply abovementioned learning indicators.

Table 1.Calculation of learning indicators

	Weeks				
Indicator	1	2	3	4	5
PL	12	40	72	84	92
Grades (% of the maximum)	33	40	50	62	87
EL (PL multiplied by Grades)	4	16	36	52	80
AL	16	24	30	40	88
LRV (EL minus PL)	-8	-24	-36	-32	-12
LPV (EL minus AL)	-12	-8	6	12	-8

To visualize and monitor student's learning results and productivity, we can build histograms for LRV and LPV. Figure 8 demonstrates the resulting graphs.

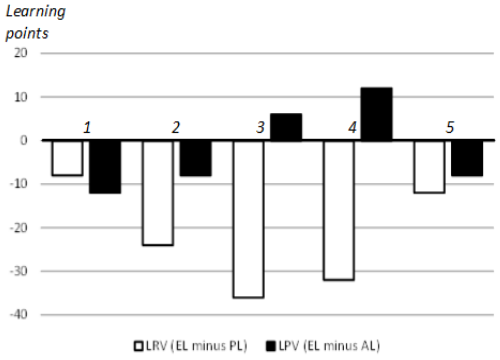

Figure 8. Exemplary histograms for Learning Results Variance and Learning Productivity Variance

The histograms demonstrate the same dynamics in the learning experience of the students as was explained previously. In addition to variances, the indices of learning results and productivity can be calculated as ratios of EL to PL and EL to AL, reproducing the logic of project management earned value method [12].

LRV and LPV indicators can be used to analyze the learning experience of the group of students. Comparing LPV with LRV, instructors can find out that the group of students with low learning results spare too many hours. As a result, teachers can revise the structure and content of the course, so that learning results become more or less equal to hours of study.

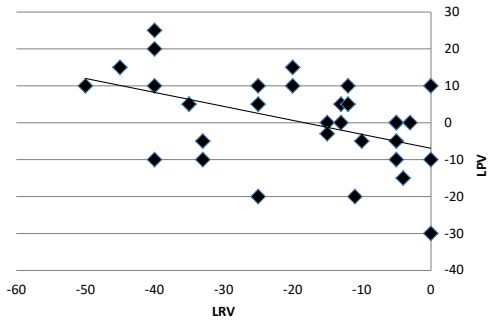

Figure 9. Scatter diagram to analyze connection between learning results and productivity

Figure 9 shows the situation in which students with low performance achieve their poor results with the efforts that were lower than it had been planned. Big negative values of LRV are associated mostly with high positive values of LPV. It suggests that low results can be achieved too easily, and the instructor should think about changing the structure and content of the course in order to increase the difficulty of the tasks associated with the low marks.

Using the integrative assessment metrics, designers of the blended courses can analyze the combination of the computer mediated and traditional activities and its impact on the learning experience. For example, we can compare students' learning results and productivity in the courses with the different ration of computer-aided learning hours and traditional ones. Figure 10 shows the values of LRV and LPV for students who learned the same discipline but in the courses with different proportion of computer-mediated and traditional learning hours. The polynomial approximation curves were built on the data received from these courses.

From Figure 10 it is clear that in terms of learning results the optimal configuration of the blended course is 50/50 – one half of hours for traditional learning and another one for computerized. Quite surprisingly, the increase in computerized learning does not lead to linear increase in hours 'saved' by the learners. We see the raise of LPV up to the level of 60% of computerized hours, but after that we can identify the moderate decline.

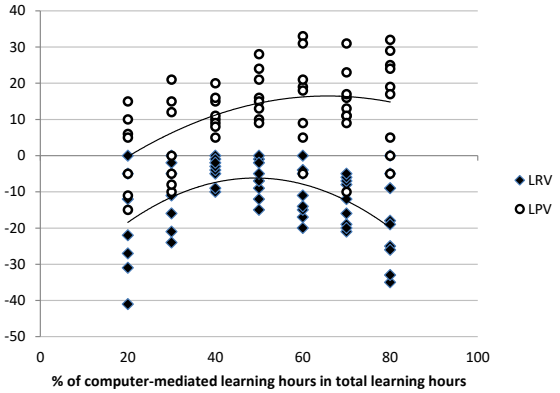

Figure 10. Scatter diagram of LRV and LPV for different blended learning designs

The integrative metrics of the blended learning courses can be used not only by the instructors and designers, but also by the students in order to track their own progress and productivity, and make necessary changes in their learning strategies. Digital systems of the blended courses can incorporate the proposed integrative assessment framework into the online dashboards and create agamified environment in which students can compare their results and productivity with the average or top levels within the group of students. Such gamified learning metrics have a motivational effect on learners.

Though the integrative assessment framework provides the opportunities for all participants to achieve the purposes of formative and summative evaluation, it is now without problems. The hours spent in classrooms can be easily monitored. However, there is usually a significant amount of time spent on self-education, including hours without using any digital device. Besides, in computer-mediated learning environments, it is difficult to discern the time of active learn from the time of passive learning or non-learning at all. Students can start an educational video, but after a while switch to another activity. We have to admit that this is a very important problem, which decreases to some degree the reliability and appropriateness of the integrative assessment framework. However, self-education time takes only a part of all learning hours in a course. Additionally, being interested in improving their learning behavior, students can provide more or less adequate data on their self-study.

6. Results of assessment framework implementation

In order to evaluate the effectiveness of the integrative assessment framework, it was implemented in a major Russian private university specialized in online and blended learning programs. The results of implementation and the feedback from participants were mostly positive. At the end of the participation in the experimental operations, students, teachers and designers were asked to answer a survey. They had to evaluate the changes in their ability to monitor learning experience (results and productivity) and to adapt the learning practices to the course (for students), the learning materials to the students' abilities (for instructors), and the course design to the students' behavior (for designers). Changes in the students' engagement and improvement of their time-management practices were also evaluated. All questions were based on 5-point scale in which 1 meant significant decrease, 2 – moderate decrease, 3 – no changes, 4 – moderate increase, 5 – significant increase.

There were 94 participants in the trial implementation. 79 participants answered correctly the survey. The experimental operations lasted one academic year and covered 4 disciplines. It is worth noting that the university under investigation before the introduction of the new assessment framework had already used some evaluation indicators to monitor the learning progress and perception of the learning materials.

The results of the survey shown in Figure 11 convincingly demonstrate the successful implementation of the integrative assessment framework based on Planned Learning, Earned Learning and Actual Learning. All analyzed parameters improved as a result of the framework introduction.

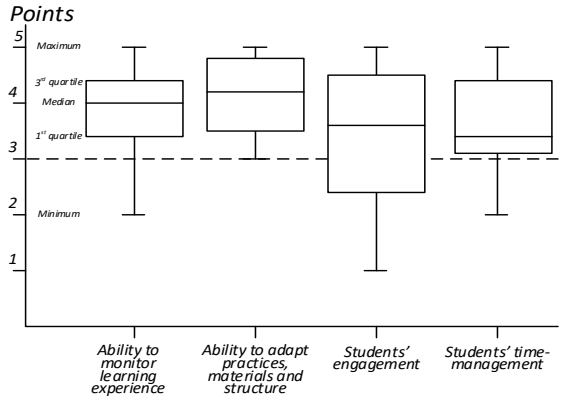

Figure 11. Box-plot diagram with the results of the assessment framework implementation

Therefore, the proposed integrative assessment framework can be considered as a practically implementable and effective tool of formative and summative evaluation in blended learning environments.

7. Conclusion

Blended learning is one of the most promising trends in modern education. Integration of traditional and computerized educational methods brings about new opportunities, among which we can identify new perspectives for collecting numerous data related to learning experience and using it to enrich evaluation methods. By transferring the basic principles of earned value method from project management to blended learning environment, the authors developed the integrative assessment framework combining both formative and summative evaluation dimensions. This framework can monitor and analyze learning results and productivity, helping students to understand their strengths and weaknesses, change their learning strategies, and in this way get used to the challenges of the course. By means of the framework, teachers are able to tune the learning materials, methods and styles to the needs of different students. Designers have the opportunities to analyze the structure and sequence of courses, and define the optimal proportion of traditional and online educational methods.

Test operations of the integrative assessment framework organized in a Russian university specialized in online and blended learning programs ended positively. They demonstrated effectiveness and the potential for further development of the proposed evaluation system.

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