

# E-Course as Blended Learning Digital Educational Resource in University

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The article presents the pilot empirical research findings of the performance of the e-course “Mathematical Methods in Psychology” as an open digital educational resource for the implementation of blended learning using the “flipped classroom” model at the university. The students’ attitudes toward blended learning in the e-course format, their self-esteem of involvement in the learning process, as well as educational results were examined. The main benefits for students are the accessibility of tutorials and information about their individual learning trajectory at any time, the convenience of self-preparation for classes. Activity at seminars is characterized by them as active interaction with classmates and with a teacher and involvement in the learning process. In general, students positively assess the use of digital resources in the blended learning educational process as a modern approach and would like to study other subjects in this format, as well as courses at other universities in Russia and abroad. Essential difficulties in studying the e-course are not revealed. The educational results of students after passing the e-course statistically significantly improved ( $p < 0.001$ ). The blended learning group educational results are significantly higher as compared to traditional full-time study group ( $p < 0.001$ ), but the finding is to be checked up more carefully and justified in the following experimental researches. The total sample size  $N = 387$  students of Moscow State University of Psychology and Education, the experimental group size  $N = 78$ . The comparison group of traditional full-time education ( $N = 309$ ) is balanced with the experimental group in context parameters — gender and age composition, training program majors, the same teacher.

**Keywords:** blended learning, flipped classroom model, e-course, mass open online course (MOOC), digital education technologies, digital educational space, educational results, Mann-Whitney test, Wilcoxon test, Chi-square test, Spearman’s correlation coefficient.

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# Электронный курс как цифровой образовательный ресурс смешанного обучения в условиях высшего образования

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Представлены результаты пилотного эмпирического исследования возможностей электронного учебного курса «Математические методы в психологии» как цифрового образовательного ресурса смешанного обучения по модели «перевернутый класс» в МГППУ. Изучались отношение студентов к смешанному обучению в формате электронного курса, их самооценка вовлеченности в учебный процесс и образовательные результаты. Общий объем выборки составил 387 студентов психологических факультетов, экспериментальная группа — 78 человек, группа сравнения — 309 студентов традиционно-очного обучения, уравновешенная с экспериментальной группой по контекстным параметрам (половозрастной состав, направления и специальности подготовки, обучение у одного и того же преподавателя, принадлежность к МГППУ). Установлено, что основными преимуществами студенты считают доступность учебных материалов и информации о своей индивидуальной траектории прохождения курса в любое время, удобство при самостоятельной подготовке к занятиям. Деятельность на семинарах характеризуется ими как активное взаимодействие с однокурсниками и с преподавателем и вовлеченность в учебный процесс. В целом студенты положительно оценили использование электронного курса в образовательном процессе для смешанной формы обучения как современный подход и высказали желание изучать в этом формате и другие предметы, а также курсы в других университетах России и за рубежом. Существенных трудностей в изучении электронного курса выявлено не было. Подтверждена достоверная связь между положительной оценкой студентами своих образовательных достижений и их позитивным отношением к новому формату ( $p < 0,001$ ). Образовательные результаты студентов после прохождения электронного курса статистически значимо улучшились ( $p < 0,001$ ). Результаты студентов в группе смешанного обучения в формате электронного курса на выходе в среднем достоверно выше, чем в группе традиционно-очного обучения ( $p < 0,001$ ). Входного среза в группе традиционно-очного обучения проведено не было, однако по контекстным параметрам она полностью аналогична экспериментальной группе, поэтому нет никаких оснований предполагать различия знаний на входе. Исследование проведено в Московском государственном психолого-педагогическом университете.

**Ключевые слова:** смешанное обучение, модель «перевернутый класс», электронный учебный курс (ЭУК), массовый открытый онлайн-курс (МООС), цифровые технологии в образовании, цифровое образовательное пространство, образовательные результаты, критерий Манна—Уитни, критерий Уилкоксона, критерий Хи-квадрат, коэффициент корреляции Спирмена.

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## Introduction

Using of digital technologies in higher education in a variety of approaches, such as blended learning, mass open online courses (MOOCs), diverse hybrid models, is a powerful global trend [9; 13]. Digital educational services market is growing rapidly, and universities that do not fit into this trend are at risk of being outsiders. According to a survey of representatives of 250 universities from 37 countries conducted by the European University Association (EUA) [6], 91% of universities successfully use a blended learning system for students, 82% simultaneously implement distance learning technologies and develop their own MOOCs. Thus, the empirical assessment problem of various aspects of learning in the digital educational space is of extra relevance.

Connecting with the trend of the digital transformation of education, blended learning technology has spread in Russian universities and schools, since not all universities are ready to switch to MOOCs and thereby sharply reduce personal communication between students and the teacher. Blended learning (BL), in accordance with the opinion of H.C. Christensen, is a formal educational program that implies a combination of traditional full-time study (TFS) with distance learning and online resources by the control elements availability by students over the place, time, individual trajectory and pace of their learning [1; 9]. In our research, the e-course “Mathematical Methods in Psychology” (EC MMinP), hosted on the LMS Moodle platform, became such a digital resource.

Considering the implementation problems of blended learning models at universities, researchers [2; 3; 8] recognize its’ advantages, in particular, in improving the quality and information capacity of training through the use of alternative sources, as well as better structuring of educational information and its presentation in different forms; greater transparency of the educational process for teachers, students and administration; in the flexibility and individualization of education, increasing its accessibility and mass character, mobility

and technological effectiveness, as well as in the development of students’ communication skills as a result of joint educational and research activities. Its individual weak points are also noted, such as the substitution of personal communication by electronic; insufficient control over student independence in testing and completing assignments; a significant burden on the teacher by developing of e-courses and verification of a large amount of reporting [5; 8], but they are not of a fundamental nature and, as a rule, allow adjustment. According to the study [4], university professors emphasize analogues advantages of MOOCs, and as disadvantages they call pedagogical imperfection of this format, special requirements for the educational system, resource costs, and professional risks for the instructor.

Many authors cite the results of sociological surveys of students, in general, showing a positive attitude of respondents to e-courses and BL. So, according to the American association “The Sloan Consortium”, about 60% of students studying in the United States believe that blended learning is much more effective than traditional full-time education [6]. An analytical review [3] presents the results of a student survey conducted at the National Research Tomsk Polytechnic University. The most important advantages of using electronic resources, students consider: constant access to tutorials and assignments; participation in online testing; the ability to complete and submit assignments through an electronic medium; the opportunity to ask the teacher questions at any time, hyperlinks to external information sources, video lectures by professors. Similar advantages when using LMS Moodle in teaching a number of special and general scientific disciplines are noted by the authors of the article [5]. The same results are confirmed by the students themselves participating in electronic courses in the BL-format according to surveys and analysis of their classmates opinions in forums [10].

In Russian studies, very few individual attempts were made to empirically evaluate

the effectiveness of blended learning in its various aspects. So, for example, in [1] it was shown that blended learning according to the “rotation of stations” model in mathematics lessons at school positively affects the quality of subject and meta-subject educational results. It seems very important to conclude that the growth of objective results is a consequence of applying not so much a specific model of blended learning as a new approach as a whole, which combines a number of factors affecting the result. In the article [12], for the undergraduate students studying course “Life Safety”, the best educational results of the blended learning group are confirmed as compared to traditional full-time study. Interactive pedagogical teamwork in the information and educational environment using e-courses contributes to the growth of students’ internal motivation to employ information technologies [7], as well as increasing the performance of various types of students’ independent activities, their self-development [15]. We note, however, that only in one of these studies methods of testing statistical hypotheses were used, and in the rest, quantitative analysis is carried out at the level of calculating averages, percent, and plotting, that is, only descriptive statistics methods, which, strictly speaking, does not provide evidence for the conclusions.

The opinions of foreign researchers regarding the advantages of various models of e-learning and blended learning differ [9]. For example, meta-analytical reviews by R. Clark, J. Bishop, M. Verleger do not confirm the effectiveness of their use in terms of educational results, and collective meta-studies by B. Means et al. or Y. Zhao et al., on the contrary, present evidence in favor of higher blended learning outcomes compared to traditional full-time and distance learning. According to R. Clark, the advantages of e-learning, including blended learning, cannot be considered proven for 2 reasons: due to a mixture of technology factors, teaching material and teaching methods, as a result of which it is impossible to understand due to which specific factor a large efficiency is con-

firmed; control groups are organized so that they do not allow an unambiguous interpretation of positive results in the experimental groups [9, pp. 14–15].

In the pilot study, we focused on exploring the possibilities of the e-course “Mathematical Methods in Psychology” (EC MMinP) that we developed as a digital resource for blended learning implementation at the university. This subject, on the one hand, plays a significant role in developing students’ skills in the quantitative analysis of psychological and educational researches empirical data and in many respects ensures quality of graduation qualification papers and evidence of conclusions, and on the other hand it is quite difficult to master, since it has a significant mathematical component and involves the active use of technical means, in particular, the SPSS statistical package. At the same time, the range of applied methods of mathematical statistics and the capabilities of modern software are constantly expanding. That is why it was so important for us to develop a positive attitude of students to the new educational format, to promote their independence and involvement, to intensify self-learning processes, not only not reducing the quality of educational results, but, on the contrary, contributing to its improvement.

**Object** of the research is the views of students and their educational results in the study of the e-course “Mathematical Methods in Psychology”.

**Subject** of the research: students’ attitude to blended learning in the format of an e-course, their self-assessment of involvement in the educational process and its performance.

**Purpose:** to test the e-course “Mathematical Methods in Psychology” as a digital educational resource of blended learning, to empirically evaluate its performance as a tool for developing of students’ positive attitude to EC-format, for supporting of their involvement in the educational process and achieving of good educational results.

**Tasks:**

1) to identify the strengths, weaknesses and possible difficulties of the EC MMinP studying,

to assess involvement in the educational process from the point of view of students,

2) to determine the relationship between the attitude of students to blended learning in the EC-format and their self-esteem of their educational achievements and the applicability of acquired competencies,

3) to evaluate empirically the educational results of blended learning students group as compared with the group of traditional full-time study.

**Hypothesis:** the study of the e-course “Mathematical Methods in Psychology” will contribute to the development of students positive attitude to blended learning in the EC-format, to their positive self-assessment of involvement in the educational process and to good educational results.

### Research design

A pilot empirical research of various aspects of blended learning performance in the format of EC MMinP, implemented on the LMS Moodle platform, was conducted at the Moscow State University of Psychology and Education (MSUPE) in February and March 2019. The main attention is paid to testing the EC MMinP capabilities as a tool for organizing the educational process in the digital educational environment in the “flipped classroom” BL-model.

At the formative stage of the experiment, students of the experimental group (EG) listened to video lectures at home, and at the seminars new information was updated in active and interactive modes — students solved psycho-educational research case-tasks in the SPSS, answered the teacher’s questions and discussed complex material. Internal EC MMinP reporting — 4 online-tests and an individual case assignment of 6 tasks — students also performed independently outside the classroom. At the end of the study, the EG students anonymously filled out the “Students’ Opinions on EC MMinP” questionnaire in the feedback mode through the LMS Moodle system.

To compare the educational results of the EG with the group of traditional full-time study

(TFS), we used data from the output testing of students who studied with us in the same discipline in the spring semester 2017/2018 and in the autumn semester 2018/2019. An input slice of knowledge of this group was not carried out, therefore we consider it to be “control group” (“CG”) only conditionally and hereinafter in the text we write this term in quotes.

Both groups — EG and “CG” — also passed an external online-test of 20 questions through the Department for Monitoring the Quality of Professional Education (DMQPE) of the MSUPE. The EG was tested twice — as an input (1st slice) prior to the study of the e-course MMinP and as an output (2nd slice) upon completion of its study. The “CG” passed only output testing. The quality parameters of an external test as a measuring tool were checked also using data from testing students of the EG in other disciplines.

We note that even without the possibility of statistically confirming the absence of differences between the EG and the “CG” at the ascertaining stage of the research, we expected that their previous knowledge level of mathematical methods in psychology is on average the same, since the EG and “CG” are balanced by gender and age composition; all testees are students of 4 psychological faculties of Moscow State University of Psychology and Education and in accordance with the curriculum previously studied the same basic discipline “Mathematics and Mathematical Statistics”, which is the basis for mastering the MMinP. For a more thorough comparison, we specifically singled out a subgroup of students “CG1” in “CG”, balanced with the EG in a number of other contextual parameters — by affiliation with the faculty, semester of study, and training program majors. All these are indirect considerations, and not strict evidence, but for a pilot study they seem to be quite acceptable.

### Data Analysis Methods

The empirical data analysis was carried out using descriptive statistics methods, non-parametric statistical tests for assessing differences for quantitative measurements (Mann-

Whitney test, Wilcoxon test), testing methods for the relationships of quantitative and nominative variables (Spearman correlation analysis, Chi-square test) [11; 14]. All these methods are nonparametric; therefore, they do not require checking whether the distributions of the studied traits are normal. The analysis is performed in the SPSS statistical package of the 23rd version.

### Sample Description

In the formative experiment participated the 4th year students (N = 78, 88.5% of girls, 11.5% of young men) of the faculties of Legal Psychology (79.5%, N = 62) and Consultative and Clinical Psychology (20.5%, N = 16) of 2 training program majors — Clinical Psychology (50.0%, N = 39) and Pedagogy and Psychology of Deviant Behavior (50.0%, N = 39). By the end of classes, 88.5% (N = 69) of students from the initial sample completed the e-course, i.e. passed all internal reporting for positive assessments, filled out a feedback form and passed the external online test. We used these data in the analysis as the results of an experimental group (EG). The remaining 11.5% (N = 9) of the initial sample students practically did not log into their account, did not attend full-time classes and did not pass output testing.

As a general “control group” (“CG”, N = 309) the data of output testing of the 3rd (N = 198) and 4th (N = 111) year students of 14 academic groups are considered. They are the students of Faculties of Legal Psychology (LP), Consultative and Clinical Psychology (CCP), Clinical and Special Psychology (CSP) and Extreme Psychology (EP), who studied with us “Mathematical Methods in Psychology” within the traditional full-time learning, among them 84.5% of girls and 15.5% of young men. Among these students were representatives of the 2 mentioned program majors — Clinical Psychology (45.3%, N = 140), Pedagogy and Psychology of Deviant Behavior (26.2%, N = 81), as well as of bachelor’s program major Psychology (19.7%, N = 61) and of program major Psychology of professional activity (8.7%,

N = 27). For a more thorough comparative analysis, we also extracted from the general “CG” the subgroup “CG1” (N = 91) of students of the same 2 faculties — LP and CCP — and of the same 2 program majors as the EG, but who studied MMinP discipline with us in TFL-format one year ago — in the spring semester of 2017/2018 year: this sample is most similar in terms of context parameters to the EG. The remaining students of “CG” were tested in the autumn semester of 2018/2019.

### Analysis Results

#### **Advantages, weaknesses and involvement in the process of the e-course MMinP studying in students’ assessments**

In the questionnaire “Students’ Opinions on the EC MMinP”, we formulated 56 closed-ended questions for students with the answers “yes” and “no”, as well as an open question: “The general impression of the EC MMinP: pros, cons, what is to improve?” The survey is anonymous, questions were presented randomly, not by topics.

Consider the most interesting results. The advantages of the e-course in students’ point of view: the availability of e-course at any time (100%), the possibility to always be aware of their grades, tasks, topics of seminars in e-course (98%), the convenience of preparing for classes and the ease of repeating what was unclear (95 %), the fact that with e-course it became easier to catch up on missing material (92%). The vast majority of students agree that e-courses and blended learning make education more accessible (97%), and that e-course is a good solution to the problems of those students who work and cannot attend classes (92%). At the same time, 86% of students prefer not to attend lectures, but to listen to their videos, and 59% think that the e-course is convenient, since an in-person presence at lectures is a waste of time. In general, it is consistent with the results of [3; 5; 10].

We tried to find out from students the possible difficulties in studying the EC MMinP, but there were practically none. Indeed, the vast majority of students deny that it is technically

difficult for them to study in the EC format (No, 89%), it was difficult for them to get used to the new form of training in a mixed format (No, 79%) or to correctly plan the time to do tasks (No, 62%). At the same time, 59% disagree with the opinion that it is more difficult for teachers, not students, to work in the EC-format: students are much more advanced in digital technologies. It is difficult to say whether this is a compliment to teachers: after all, almost 40% of students confirm this point of view!

Very interesting for us were questions about the involvement of students in the learning process, about their independence and how the instructor managed to organize their interaction. It was nice to know that 65% of the students systematically studied the EC-tutorials from the very beginning, 80% communicated with classmates at the seminars in order to better understand the subject, 76% provided assistance at the seminars, and 68% received the help of classmates. In addition, 62% of respondents often answered questions from the instructor, and 97% completed the final case-task on their own.

What is more preferable for students — EC and blended learning or MOOCs? How much do they need personal contacts with the teacher? It turned out that 74% of respondents deny that it is difficult for them to work independently in the EC without the help of a teacher, and also that in the EC they had few personal contacts with the teacher, therefore, there were enough contacts. However, most students do not agree to replace face-to-face meetings with the instructor only for videos and contacts through forums (No, 80%), as well as through webinars (No, 70%). All this speaks more likely in favor of students' preference for blended learning.

Evaluating their attitude to the EC-format, 83% of students agree that they liked the EC as a modern form of education, 59% want to study other subjects in the EC format, and only 14% say that they do not like the EC-format and they don't want to so learn. It is very significant that 80% of respondents would like to study some courses at other universities in Russia with the right to be recognized at the

MSUPE, and 76% think that it would be interesting and useful for them to take a course at a foreign university with the right to be recognized at the MSUPE. However, this is possible only in MOOCs, therefore, this format also has good prospects to be in demand.

Among the recommendations of students to improve the process of studying EC are: to devote more time to solving practical problems in SPSS, more evenly distribute seminars in the schedule, as well as time between seminars, homework and testing. Students' comments were sometimes contradictory: information about the deadlines for reporting on the EC-modules seemed to be not enough for some respondents, while for the others, on the contrary, the instructor's control seemed redundant. Some of them were unaccustomed to great independence in the study of the course: they wanted to work at the same pace with the whole group. However, the solution of case-tasks in the old fashioned manner "under the dictation of the instructor" is not exactly assumed here, nor is movement along the course at a uniform speed: hence there is the feeling of "instructors' less involvement" among some students. We focused on the independent work of the student at an individual pace suitable for him, on the interactive nature of the students' work at the seminar, their self-study and mutual learning. Particularly important for us was the cooperation of students and the instructor: the instructor understands students' problems (work, family, health, etc.) and provides them with all the opportunities to study in a mode convenient for them, and students realize that they need the subject for the graduation qualification papers creation and for scientific researches and responsibly relate to its study.

Students also expressed a lot of positive feedback on the EC MMinP, among which there is much greater efficiency than full-time study; high information content of the course, structured learning material and the availability of its presentation in different formats with a large number of examples and analogies; practical benefit for scientific

work. There was marked even an increase in interest in mathematics, which is not a core subject at all.

**The relationships between students' attitudes to the EC-format and self-assessment of their educational achievements and of the practical applicability of acquired competencies**

A quantitative analysis of students' opinions allowed us to identify reliable relationships using the Chi-square statistical test. We give only three of the most striking examples of reliable relationships (Table 1, Table 2 and Table 3).

Among students who believe that he has gained new and useful information, 91.1%

(51 respondents) say that they like the EC-format as a modern form of education, and among those who did not receive such competencies (there are only 11 of them), 54.5% (6 respondents) deny that they like the EC-format ( $p < 0.001$ ).

Among students who are already aware of what methods will be used in their course works or graduation qualification papers, 75% (27 respondents) say that the final internal EC-test did not cause difficulties for them, and among those who do not know them (31 students), in 54.8% (17 respondents) the final test caused difficulties ( $p < 0.05$ ).

Among students who do not like the EC-format at all (there are only 9 of them), 55.6% (5 respondents) agree that ECs lead to degra-

Table 1

**The relationship between opinions on acquired competencies and attitudes towards the EC-format**

			I liked EC-format as a modern form of education		Total
			No	Yes	
I have a feeling that I really learned a lot of new and useful about the application of mathematical methods in psychology and education	No	Frequency	6	5	11
		% in the row NO	54,5%	45,5%	100,0%
	Yes	Frequency	5	51	56
		% in the row YES	8,9%	91,1%	100,0%
Total		Frequency	11	56	67
		% in the rows NO and YES in total	16,4%	83,6%	100,0%

Table 2

**The relationship between opinions on the practical applicability of the competencies gained and the absence of difficulties in performing the final test**

			The final test for EC caused me difficulties		Total
			Yes	No	
I am already aware of what mathematical methods I use in my course work or graduation qualification paper	No	Frequency	17	14	31
		% in the row NO	54,8%	45,2%	100,0%
	Yes	Frequency	9	27	36
		% in the row YES	25,0%	75,0%	100,0%
Total		Frequency	26	41	67
		% in the rows NO and YES in total	38,8%	61,2%	100,0%



Table 3

**The relationship between negative attitude to the EC-format and the negative assessment of its applying in education**

		E-courses lead to degradation of the education quality		Total	
		No	Yes		
I do not like the EC-format, I don't want to study like that anymore	No	Frequency	52	6	58
		% in the row NO	89,7%	10,3%	100,0%
	Yes	Frequency	4	5	9
		% in the row YES	44,4%	55,6%	100,0%
Total		Frequency	56	11	67
		% in the rows NO and YES in total	83,6%	16,4%	100,0%

gradation of the quality of education, and among those who like this format (there are 58 of them), 89,7% (52 respondents) do not think so ( $p < 0.01$ ).

Thus, if students believe that they really acquired a lot of new and useful information about the application of mathematical methods in psychology and education, then they are more likely to like the EC-format. If they are already aware of what mathematical methods they can use in their graduation qualification paper, then the final test on the EC MMinP, as a rule, does not cause difficulties for them. If they do not like the EC-format at all, then they more often agree that this format leads to degradation of education quality.

**The EG educational results comparison according to an external output online test before and after studying the EC MMinP** was carried out according to the Wilcoxon's sign rank test in a sample of  $N = 68$  students. EG indicators at the control stage are significantly higher than at the ascertaining one ( $p < 0.001$ ), that is, they can no longer be explained by random factors, such as individual characteristics of students, their motivation, abilities, various test strategies, performance, class attendance, etc. They increased on average from 40.3% to 75.1% of correct answers, that is, by 34.8% test points. Since the test consists of 20 questions, 5% corresponds to one question, therefore, at the output, EG students correctly answered an average of 6.96

more questions. At the same time, in 63 students the result improved, in 4 — it worsened, in 1 — it did not change. At the output, the scattering of test scores around the mean increased ( $SD1 = 13.7$  vs  $SD2 = 17.8$ ), i.e. the results have become less uniform.

**Comparison of the educational results of the EG and "CG" according to the external output online test after the EC MMinP completion** was carried out using the Mann — Whitney test. We compared the output test indicators in the EG and in the total "CG" ( $N = 309$ ). The educational results in the EG are on average significantly higher than in the "CG" ( $p < 0.001$ ). The average level of competencies in the EG ( $M1 = 75.07$ ) is higher than in the "CG" ( $M2 = 67.28$ ) by 7.79 percentage points, that is, students in the EG answered correctly on average 1.55 more questions than in "CG". Moreover, the scattering of test scores around the average practically does not change ( $SD1 = 17.66$ ,  $SD2 = 17.52$ ).

For a more detailed assessment of the differences, we also compared the EG indicators ( $N = 69$ ) and the "CG1" group ( $N = 91$ ), which are completely similar in composition and contextual parameters, to 4th year students of the same departments of LP and CCP, of the same 2 training program majors, but who studied with us the MMinP course at the TFS-format one year ago. The EG indicators on average are significantly higher ( $p < 0.001$ ) than the "CG1" ones ( $M1 = 75.07$

vs  $M_2 = 63.02$ ) by 12.05 percentage points, which corresponds to 2.41 questions, that is, these differences are already cannot be explained by random factors. In addition, the standard deviation in “CG1” students is only slightly higher, which indicates a slightly larger scattering of points around the mean ( $SD_1 = 17.66$ ,  $SD_2 = 18.54$ ).

**The quality of the external online test** assessing competencies on mathematical methods in psychology has also become our focus, as it is a measuring tool and its characteristics require empirical verification. Note that, strictly speaking, students did not pass the same test at the input and output, as well as tests inside the EC, but similar tests, comparable in difficulty. Let us explain how the output test was built (it is also the input test). We developed 100 questions for him, divided into groups of 5 questions of the same type. Of these, for each student, the HT-Line program used at DMQPE of the MSUPE generated an individual test of 20 questions, choosing one question from each of the five in random order. Of course, two different students might accidentally have the same question in the tests, but the order of answers to choose one right variant from 4 provided ones also changed. Tests inside the EC MMinP we programmed on the same principle. We used this approach to make the “exchange of information” and “mutual consulting” of students difficult during testing.

Let us explain what is meant by the same type of questions. For example, in a case-type question, a task from the field of psycho-educational researches is considered and it is proposed to choose an appropriate method for solving it from 4 options. In all questions of the same five, the themes and context of the research are different, but from a mathematical point of view, this is the same situation requiring the use of the same statistical test. Students should understand the mathematical meaning of the problem, regardless of the context of the research. The difficulty coefficients of the test questions were calculated by the HT-Line program. The generated tests of 20 questions are comparable in difficulty: as a rule, they contained 5 easy questions (25%),

11 questions of medium difficulty (55%) and 4 difficult questions (20%).

Differential validity, understood as the ability of a test to find out differences on context variables, is confirmed by significant differences between groups in mathematical statistics competencies and using SPSS in the course “Mathematical Methods in Psychology”. Correlations with an external criterion reflect structural validity. The indicators of the output test directly correlate with the test rates in “Mathematics and Mathematical Statistics”, which students of 2 academic groups from the EG passed in the autumn semester of 2018/2019, i.e. about 4 months ago. The relationship is direct medium ( $\rho = 0.456$ ,  $p < 0.01$ ). This means that the higher the performance in “Mathematics and Mathematical Statistics”, the better the results in EC MMinP, which is quite expected and explainable. In addition, the output external test directly and significantly correlates with internal tests on the EC — Test 1 ( $\rho = 0.326$ ,  $p < 0.01$ ), Test 2 ( $\rho = 0.302$ ,  $p < 0.05$ ) and Test 3 ( $\rho = 0.458$ ,  $p < 0.001$ ) for Modules 1, 2, and 3, with a final score for the EC MMinP ( $\rho = 0.434$ ,  $p < 0.001$ ), however, all correlations are weak or medium. With the tests in the disciplines “Forensic Psychology”, “Psychology of Deviant Behavior”, “Psychology of Conflict”, which students of the EG passed in the fall of 2018, no connection was found, which is also quite expected.

## Discussions

The results of the pilot research, in our opinion, can be considered encouraging. A qualitative analysis of the students’ opinions allows us to conclude that the overwhelming majority of respondents agree with the alleged advantages of the EC-format and blended learning, as well as they deny of any significant shortcomings of this approach. Students’ activities at seminars are characterized by them as active interaction with classmates and instructor, independent work and involvement in the educational process. Most confirm the desirability of personal contact with the teacher, and not just through webinars and forums. In general, students posi-

tively assessed the EC-format as a modern teaching method, expressed a desire to study other subjects in this format, as well as courses at other universities in Russia and even abroad with the right to recognize them at the Moscow State University of Psychology and Education. This is in good agreement with the results of previous studies, for example, [3; 5].

Significant differences were obtained in the indicators of competencies in applied mathematical statistics and the SPSS program in the course “Mathematical Methods in Psychology” in the EG between slices: the output educational results are significantly higher than input ones. The educational results of EG-students are significantly higher as compared with “CG”-students who studied this course at the TFL-format, however, the finding seems to be less convincing because there was no input testing of “CG”-students, and absolute difference in mean values is small.

And yet, we emphasize once again that the main effect is not only improving of educational results, but, above all, a fundamental change in the nature of the teacher’s interaction with students, the methodology of our work using the resources of the digital educational environment, as well as an increase in the involvement of students in the process of independent studying of the EC. Our own impressions of working in the new EC-format are very positive, and so much so that we simply don’t see any reason for ourselves to return to traditional full-time study methodology.

In our experience, the advantage of blended learning in the EC-format for the educational process is an increase in the intensity of training: the classroom learning time is significantly reduced — in our case, 1.5 times due to the lectures that students listened to in the videos — with an increase in the volume of material. Individualization of training becomes a reality: the teacher has the opportunity to interact with students in any mode, taking into account their needs — employment, departure for internships and studies, family circumstances, health conditions, etc. The educational process is gaining flexibility: instructor

has an opportunity to “rebuild” seminar on the go, vary the topics and pace of the study, the complexity of the tasks, the time taken to complete the tests. Since the emphasis is on the independent work of students, the teacher becomes a moderator, organizer who helps students study the subject themselves and explains the most difficult points.

The interaction of the teacher with students in the EC-format also, in our opinion, has a number of advantages. First of all, it is the transparency of interaction and the ability to control students’ activities: one can see the time of entry into the EC-account, the passage of the course elements, reporting of any student and the group as a whole. Convenience and intensity of contacts with students is also growing due to the possibility of sending information through forums both for the whole group and in an individual mode, when students receive it at their email address. Our observations confirm the growing involvement of students and their business spirit due to a shift in emphasis to active and interactive teaching methods at seminars when using the capabilities of the EC-digital educational environment instead of lectures. Finally, due to the availability of all tutorials to students 24 hours a day, their typical arguments in defense of their academic failure — “I was sick for the whole semester”, “I have difficult family circumstances”, “I work” — lose their meaning.

Let us discuss briefly some technical aspects of the teacher’s work in the digital educational space in the EC-format. One need to spend considerable time on preparing tutorials for e-course only once: in the future they can be modified, it is easy to add and replace some materials with others. There is no need to repeat the same lecture many times. But it’s especially convenient to create and use tests using the question bank: in 5 to 10 minutes, a test is created with any settings — the number of questions, topics, dates, time limits, number of attempts, accessibility for groups, individual settings. Mastering modern digital resources can not only improve the teacher’s qualifications, but also his motivation and even self-esteem.

At the same time, the limitation of our pilot study findings, as already mentioned, is the lack of data for entrance testing of students who took the course “Mathematical Methods in Psychology” with traditional full-time education, which somewhat reduces the evidence of better educational results in blended learning in the new format of e-course. In addition, each discipline has its own specifics, so it is difficult to say whether it is possible to generalize the results obtained to subjects of the humanitarian or natural science cycle. In our opinion, it is necessary to continue empirical researches of educational results when organizing experiment under controlled conditions, as well as the study of other parameters in addition to assessing subject competencies, for example, meta-subject results, educational motivation, various aspects of the personal development of different categories of students, including those with disabilities and limited health opportunities, in the other academic disciplines.

### **Conclusions**

The e-course “Mathematical Methods in Psychology” has been developed and tested as a digital educational resource for the implementation of blended learning at the university. Empirically confirmed its performance as a tool for the development of students positive attitude to blended learning in the EC-format and their positive self-assessment of involvement in the educational process.

Significant difficulties in the studying of EC MMinP were not revealed. Students’ recommendations for improving the educational process mainly concerned the strengthening of the practical component of the course and its’ better planning. Opinions on particular issues diverged, for example, information on the deadlines for reporting on the EC-modules seemed insufficient to some students, while redundant to others. Greater independence in the study of the e-course was also evalu-

ated ambiguously. In their positive reviews, students noted significantly greater effectiveness than full-time study, high information content of the course, structured material and the availability of its presentation in different formats with a large number of examples and analogies, its’ practical benefit for scientific researches. Reliable relationships were found between a positive assessment of practical applicability in various aspects of the competencies gained and positive attitude to the EC-format and blended learning ( $p < 0.001$ ,  $p < 0.01$ ,  $p < 0.05$ ).

It is shown that the new studying format, which implies a fundamental change in the nature of the teacher’s interaction with students, their joint work using the resources of the digital educational environment, as well as a significantly greater learning intensity and student independence, contributes to a statistically significant increase in their competencies compared to the initial level. Significant differences were obtained in the educational results of students in the EG before and after completing the e-course: at the control stage, the level of competencies in mathematical statistics and mastering the SPSS program in the course “Mathematical Methods in Psychology” is significantly higher than at the ascertaining one ( $p < 0.001$ ).

Reliably better educational output results in the course “Mathematical Methods in Psychology” were revealed in students of blended-learning group in the EC-format (EG) as compared with students of traditional full-time education (“CG”): the competencies of EG students were significantly higher than “CG” ones ( $p < 0.001$ ), however, in absolute values, the difference in the means is small. The latter conclusion, in need of additional verification, nevertheless allows us to make an optimistic assumption about the effectiveness of blended learning in the EC-format in terms of educational results. It can become a good basis for the active promotion of e-courses in the educational process at universities when extending related studies.

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