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Attitudes towards Digital Educational Technologies among Russian University Students before and during the COVID-19 Pandemic

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Abstract: The COVID-19 pandemic has dramatically accelerated the digitalization of education around the world. There has been a lot of recent research on university students' attitudes towards digital educational technologies (DET) in different countries, but much fewer studies examine how these attitudes change during the pandemic. The purpose of the present exploratory study is to compare the attitudes towards DET among Russian university students majoring in psychology before the start of the pandemic and at its different stages. A mixed method research design was used. The quantitative part of the study included *The University Students' Attitudes toward DET Questionnaire* developed by the authors, and the qualitative part of this study included percentage and thematic analyses of answers to additional multiple choice and open-ended questions. The main findings of the study confirm significant changes in attitudes towards DET at the very beginning of the pandemic, and their relative stabilization later. Additional analysis based on the literature review revealed that the advantages and disadvantages of DET listed by Russian university students and students from other countries, generally coincide. The data obtained will be useful in the development of digital competence among university students.

Keywords: digitalization of education; digital competence; university students; attitudes towards digital educational technologies; remote learning; COVID-19 pandemic



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1. Introduction

The digitalization of modern society is one of the main trends of the 21st century. Klaus Schwab in his book "The Fourth Industrial Revolution" [1] predicted the coming of the fourth industrial revolution, which is closely related to the phenomenon of artificial intelligence and the digitalization of everyday life. The COVID-19 pandemic caused an explosive growth of digitalization processes in almost all aspects of modern life, while the digitalization of education has become one of the most discussed issues. Currently, hundreds of articles have been published on various aspects of the digitalization of education [2], and many of them analyze the perception and attitude of students, teachers, and parents to digital technologies and their implementation in learning and teaching [3–21]. We believe that many of the difficulties associated with the digitalization of education and development of digital competence, which have become more obvious during the pandemic, are associated not only with objective problems, for example, technical problems, but with the psychological characteristics of all participants in the educational process and with their subjective attitude to digital educational technologies (DET). It should be noted that in our previous publications [22–24] and in the present study, the DET is considered in a broad sense, which includes: (1) digital (electronic) educational materials (e-books, e-tutorials, multimedia presentations, achievement tests, quizzes, etc.); (2) digital educational resources (electronic databases, e-library systems, search systems, etc.); (3) digital

educational systems (LMS, Moodle, etc.); (4) digital platforms used for training (ZOOM, MS Teams, etc.); and (5) artificial intelligence and digital (virtual) educational environment. Therefore, DET includes all elements of the education system that use not 'traditional', but digital tools, methods, and systems [22–24].

Now more than 2 years have passed since the pandemic outset, so it became possible to identify a change in attitudes towards DET before and after the start of the pandemic, as well as at different stages of the pandemic. Indeed, there are recent studies on changes in university students' attitudes toward DET during the pandemic in different countries including Russia [19–21,24]. However, we are not yet aware of studies that compare attitudes toward DET before and after the onset of the pandemic using the same methodology and the same or similar samples of university students.

Therefore, the main purpose of the present exploratory study is to compare the attitudes towards DET among Russian university students majoring in psychology before the start of the pandemic and at its different stages.

2. Literature Review

2.1. *Studies of the Attitudes towards DET before the Pandemic*

Even before the outbreak of the COVID-19 pandemic, many studies were conducted around the world on the use of digital technologies in education and on the factors affecting various aspects of university students' attitudes towards DET.

D.G. Duncan and C.C. Barczyk studied the impact of Facebook on learning in higher education using the example of two US universities (California and Indiana) in 2016 [25]. The research results show that students who participated in Facebook-enabled courses found Facebook to be a convenient and quality-oriented addition to their traditional courses, experienced a sense of connectedness with their fellow students, and had greater engagement in learning-related dialogue than students in non-Facebook courses. [25]. Similar conclusions about the positive role of using social networks for the development of self-organization and cooperation among students were made by M. De Martino et al. [26] based on a review of a number of articles from 2015–2018 [27–29] and authors' own teaching experience.

F. Guillen-Gamez, S. Martinez, and X. Ordonez studied the attitudes towards ICT (Information and Communication Technology) among education students according to gender and educational modality at the universities of Madrid (Spain) during the first semester of the course 2016/2017 [30]. This research revealed the existence of general positive attitudes towards ICTs in all students, but distance students had more favorable attitudes towards ICTs compared to face-to-face students, and male students had more positive attitudes towards ICTs than female students. Previous experiences with the use and access to ICTs also influenced attitudes, especially in female students. Finally, perceived usefulness of the ICTs is fundamental in the development of positive attitudes, both in male and female students [30].

F. Ozdamli researched attitudes and opinions among special education candidate teachers regarding digital technology at the Near East University of Cyprus in the 2017–2018 academic year [31]. Findings of this research showed that the students had a positive attitude towards the use of digital technologies in learning, they felt confident in reaching information on the Internet, and they preferred tablets and mobile applications to consolidate learning and to award. Respondents also believed that the integration of technology into learning processes raised their motivation and interest in the subject. The candidate teachers had positive views about the use of technology by the special education students in their learning process [31]. Similar results were obtained around the same time by M. Andrew et al. [32]. These researchers investigated students' attitudes towards technology and their preferences for learning tools/devices at two universities in the UAE. The authors concluded that students enjoyed learning how to use new technology and believed it improves learning and prepares them for future jobs. However, books and papers were the most preferred resources for learning, followed closely by laptops, while tablets and

smartphones were much less preferred for educational tasks. The authors also emphasized that university students preferred learning through a combination of traditional resources and digital technological tools [32].

H. Santos and a group of authors analyzed the views of Portuguese university students on the use of communication technologies (CT) to communicate with teachers [33]. Data collection was carried out by filling out an online questionnaire by students in 2018. The study found that the most frequently used CT by students is email, followed by publishing and sharing technologies for communicating with faculty through the Moodle LMS platform. These CTs were found by students to be useful and easy to use, satisfying, and performing as expected. At the same time, video conferencing and voice systems, as well as social networks, were rarely used or not used at all to communicate with teachers [33].

Research by R. Peytcheva-Forsyth et al., in 2018 was aimed at studying the factors associated with the attitude of undergraduate students from various faculties of Sofia University in Bulgaria to online learning [34]. First of all, the study revealed a positive attitude of students towards online distance learning. Most of the students not only used information and communication technologies in their daily life, but also liked to actively use ICT in their education. At the same time, girls more often than boys preferred to receive teacher support in online learning; younger students tended to use ICT more actively in their learning than older students; working students were more in need of distance learning, and it would be more suited to their needs than the needs of “unemployed” students. However, no correlation was found between the form of education (full-time and part-time) and the attitude of students to distance learning [34].

In Russia, before the COVID-19 pandemic, much less research of this kind was carried out. An example is an online survey of students from several Russian universities conducted by sociologists from the Ural State University of Economics in January 2019 and covered 400 undergraduate and graduate students via Simpolly service [35]. This research showed that the importance of distance and online learning for students is low: only about 50% of the respondents noted the need for distance learning and online courses, and only 30% of respondents were open to blended learning [35]. Therefore, it should be noted that before the pandemic, Russian university students had a more negative or neutral attitude towards DET compared to university students from other countries. Perhaps this is due to the fact that until recently, according to L.V. Baeva, the development of digital education in Russia lagged far behind many other countries [36].

Thus, in studies performed before the start of the pandemic, it was shown that the positive attitude of university students to the use of DET may be associated with the activity of using digital technologies in general, involvement in communication with other users in the digital space, and the experience of learning using remote and digital technologies [26,30,34,37,38]. D. Gray and A. Di Loreto, based on a comprehensive model of students' perception of the effectiveness and satisfaction with distance education, showed that personality traits play a leading role in these processes [39]. In a study by E.P. Belinskaya and N.V. Fedorova on a Russian-speaking sample of students of distance courses, conclusions were confirmed both about the role of students' personality traits and involvement in the learning process as factors of a positive attitude and use of DET [40].

In our previous research, we studied relationship of attitudes towards DET with psychological features and academic achievements in Russian university students [22,23,41]. First of all, we found that there is a specificity of attitudes towards DET in university students from different field of study (natural sciences, medicine, and psychology): medical students had worse attitudes towards DET than students of other fields of study. However, psychological students have the relatively lowest indicator of digital competence [42]. Our further research revealed that the Five Factor Model (FFM) personality traits and academic motivation are associated with attitudes towards DET [22,23]. Findings of these research showed that university students with more pronounced extraversion and openness from FFM personality traits and intrinsic academic motivation are more involved in the digital space in general and more involved in the use of DET, while more amotivated

students, in contrast, less involved in the digital space and in the use of DET [22,23]. At the same time, higher performing students tend to be more involved in the digital space in general [23]. However, there is a specificity of these relations in students from different field of study: attitudes towards DET are more closely related to personality traits and academic motivation in the natural science and psychological students than in medical students [22,23]. We assume that these differences may be related both to the specifics of professional education in each of these areas, and to the peculiarities of the use of the DET in different universities.

2.2. *Studies of the Attitudes towards DET at the Beginning of the Pandemic*

Since the start of the COVID-19 pandemic, issues of digitalization of education have become, perhaps, one of the most discussed all over the world. At the same time, all participants in the educational process had the opportunity to test the effectiveness of DET in practice and directly feel their pros and cons. A large number of international studies in 2020–2022 are devoted to the analysis of the processes currently taking place in education and the problems associated with the transition to online [2].

Many studies dealt with various aspects of the use of DET by students during a pandemic: the adoption of distant forms of education by students; attitudes, expectations, views of students on the transition to online learning; the impact of the pandemic on the learning process; etc.

For example, M. Rizun and A. Strzelecki studied the adoption of distance learning technologies by Polish students during the beginning of the COVID-19 period in May–June 2020 [10]. The study tested and used an adapted General Expanded Technology Adoption Model for e-Learning (GETAMEL) in the context of the coronavirus pandemic. The results showed that students have an average level of feeling of increased efficiency and productivity in distance learning. Students find that IT distance learning tools are intuitive and overall comfortable with computers and the Internet, and plan to use distance learning frequently throughout the semester. However, despite the positive feedback on distance learning, students would like to return to traditional learning [10].

K. Chaturvedi et al., investigated the impact of COVID-19 on the education, social life, and mental health of students of different age groups from various educational institutions in Delhi, India at July 2020 [11]. In particular, it was found that more than a third of the respondents reacted negatively to online classes, a third had an average level of satisfaction, and a little less than a third of the respondents left a positive review. At the same time, the level of satisfaction varies significantly depending on the age groups. About half of the subjects in the 18–22 age group spoke negatively about online classes, while in the 7–17 age group, only about a third of the respondents did, although they devoted more time to online lessons. In addition, more than half of those in the 7–17 age group used smartphones, while the majority of students in the 18–22 and 23–59 age group used a laptop or desktop computer for study [11].

M.C. Radu and a group of authors conducted a survey of students on the impact of the COVID-19 pandemic on the quality of the educational process in one of the Romanian universities during the summer 2020 holiday [12]. It was shown that the majority of students were satisfied with the organization of distance learning at the university during the period of isolation. However, some negative aspects were reported, such as: lack of adequate infrastructure for some students, less effective communication and interaction between student and teacher, inability to complete practical tasks, lack of socialization, lack of motivation to learn, less objective exams (cheating), and the possibility of deterioration of physical and mental health (too much time in front of screens, sedentary lifestyle, etc.) [12].

S.P. Gonçalves et al., studied the attitudes of Portuguese university students regarding compulsory digital and distance learning university courses during the second semester of the academic year 2019–2020 after the beginning of the COVID-19 pandemic [13]. The results show that the majority of the participants (74.6%) report that the COVID-19 pandemic will have a quite high impact on their academic journey. The barriers associated

with the online regime were reported by 90% of the participants: the excess of activities and work proposed (19.9%), and the lack of concentration (12.6%) were highlighted by the students. However, at the same time, the students identified the following advantages of the online education: the location flexibility (30.5%) and time saving (20.9%). In addition, correlation analysis showed that the more students perceived the pandemic as an impact on their academic path, the less satisfied they were with online classes and digital assessment of their academic performance [13].

Ati S.D. Martha and colleagues [14] investigated the students' e-learning readiness at several public and private universities in Indonesia in March–April 2020. The results showed significant differences in students' e-learning readiness based on the academic year at university, the field of study, the level of organizational e-learning culture of the university, gender, and region. For example, first- and second-year students had better competence in using DET, but third- and fourth-year students were more disciplined when attending online classes. Students of economics and engineering fields were more independent in the online learning process; sociology, politics, and humanities students preferred to co-create new knowledge and were more likely to engage in critical discussions in online learning; students from the field of education sciences rated their readiness for e-learning more highly but made less effort to initiate interaction with other members of the learning community. Female students were better able to implement logical problem-solving steps, search for information beyond the online community, and were more likely to engage in critical discussions, while male students were better able to manage their time to attend online classes [14].

I. Bakhov et al. [15] conducted a survey on the quality of distance learning organized during the quarantine period in April–May 2020 at the Oles Honchar Dnipro National University (Dnipro, Ukraine). The results showed that the most important benefits of distance (digital) learning for students are as follows: the opportunity to study in a convenient and comfortable place, the opportunity to combine work with study, the development of self-control skills, motivation for self-education, and the use of DET. According to students, the difficulties that affect the organization of full-fledged distance learning include: a large amount of homework, fatigue due to prolonged work at the computer, and lack of necessary equipment and/or stable Internet access. In total, 91% of respondents believe that the skills of using DET will be useful in their further professional activities. At the same time, 67% of students would like only some elements of distance learning to be used in the future, after the end of quarantine, 15% of students doubt the advisability of using them, and 12% of students are completely against the use of distance technologies in the future [15].

A.R. Drozdikova-Zaripova et al. [16] investigated the educational activity of the Kazan (Volga Region) Federal University students (Russia) at the end of April 2020. According to 42.2% of the respondents, distance education can only partially replace face-to-face education. Students believed that the advantages of distance learning include, first of all, independence from location, comfortable conditions during classes, and time saving, and they attributed the high workload and technical problems to the difficulties of distance learning. Moreover, half of the students had difficulties in self-organization of learning, and 24.3% in receiving feedback from teachers. Answers to the question "Would you like to continue studying in a distance format?" were distributed as follows: "no"—43.1%, "difficult to answer"—34.9%, and "yes"—22% [16].

Dan Li examined Chinese students' perceptions of online classes during the pandemic in May 2020 [17]. The author's questionnaire was administrated to 342 undergraduate students at the Economics and Trading department of the Hunan Railway Professional Technology College in China. These students named creating a digital learning community, improving students' digital learning skills, and staying connected during tough times as advantages of online classes, and they listed adaptability and time-management issues and technological obstacles as disadvantages of online classes. Most students believed that a blended educational model is necessary for the post-pandemic era [17].

Musarat Yasmin conducted an online survey of 1144 students in Pakistani institutions offering the degree of chemical engineering [18]. The results of this survey showed a negative attitude towards online learning during COVID-19 among the majority of students: 80% did not want to continue the online learning after pandemic, 79% did not enjoy the online learning experience, and 68% found it a bad experience. It is interesting that Pakistani students do not agree with the opinion that online learning had benefits in terms of time, comfort, and learner autonomy; they regard the online classes as non-interactive, with little opportunity for group study, producing frustration and poor grades. The author of the study believes that such responses of students are associated with their lack of prior online learning experience [18].

Thus, at the beginning of the pandemic, most university students around the world similarly assessed their experience of switching to fully distance learning, its disadvantages (task overload, difficulties with self-organization and motivation, a large number of technical problems, lack of digital competence of students and teachers), and its advantages (time saving, the opportunity to learn anywhere, the opportunity to develop new competencies). At the same time, the majority of students were negative about the prospect of continuing education only in a digital (distance) format after the end of the pandemic.

2.3. Studies of the Dynamics of Attitudes towards DET during the Pandemic

Two years passed since the beginning of the pandemic, therefore, studies have appeared that compare attitudes towards the use of DET at different stages of its course.

For example, S. Unger and W. R. Meiran [19] surveyed 82 undergraduate students (Wingate University, Wingate, NC, USA) from across majors and academic years during the first two weeks of the COVID-19 crisis in which all courses were transferred online. The majority of students (91.5%) responded that online learning would not be the same as in-class learning, many of them (75.6%) responded they held some level of anxiety towards rapidly shifting to finishing a semester online, and yet only 64.6% felt well prepared for emergency situations. A follow up survey consisting of one question (“Do you feel less anxiety towards online learning now?”) revealed improvement in 51.4% students that stated they felt less anxiety towards online learning after 3 weeks [19].

G. Vladova and colleagues conducted a longitudinal study of students from four German universities and their acceptance of digital learning during the COVID-19 pandemic in 2020 [20]. The study revealed the expected significant differences in attitudes towards learning fully mediated by digital technologies, depending on the discipline studied: students studying music and art were more negative about learning using technology than students studying information systems. At the same time, all students noted social isolation as a negative factor. In addition, student attitudes towards fully digital learning changed over time during the semester (the first wave of COVID-19) for the worse, especially declining in the last month of the semester among students studying music and art [20].

I. Aleshkovski and colleagues presented a public opinion poll of the Russian university students conducted with the support of the Russian Professors Assembly [21]. The main purpose of this study was the comparison of students’ opinions on the educational activities of the Russian universities at two pandemic stages: during the forced switch to distance learning in the spring of 2020 and during the planned switch to such format in the end of 2020—beginning of 2021. This survey was completed by 31,423 university students in June 2020 and 32,358 students in February 2021. In general, at the second stage of the study, the proportion of those students who believed that the remote format worsened the quality of education significantly decreased from 43.7% to 30.6%. Another 34.6% of students (versus 27.7% at the first stage) stated that distance learning does not affect the quality of education. Improvement in the quality of distance learning during pandemic period was recorded by 16.5% of students (versus 11.4% at the first stage). The results of the two surveys show that the first and mostly negative impressions of distance learning among Russian university students were changed by more balanced estimates and recognition of the positive aspects and possibilities of remote learning in pandemic extreme conditions [21].

In our previous research [24], we compared Russian university students' attitudes towards DET before (in February–early March 2020) and after (late May–early June 2020) the start of COVID-19 pandemic at three large Moscow universities. We found that students, in general, positively assessed the e-learning experience gained in spring 2020. As was expected, there was an increase of students' involvement in the digital environment and in the use of DET after the start of pandemic. However, their digital competence has not practically changed, and this, in our opinion, is due to the urgent transition to distance learning, which did not allow paying attention to the development of participants' digital competencies. Medical students showed the most pronounced positive shift in attitudes towards DET, while before the pandemic and the transition to the remote education, they treated DET with more restraint than the psychological and natural sciences students [24].

Thus, the research showed a change in the university students' attitudes towards the use of DET during the pandemic; however, there are contradictions in the data on the nature of these changes among students of different field of study and students in different countries.

3. Methodology

3.1. Design

A mixed method research design was utilized as it provides a more specific way to determine the change in university psychology students' attitudes towards DET during the COVID-19 pandemic.

The quantitative part of the study included *The University Students' Attitudes toward DET Questionnaire* developed by the authors and psychometrically tested [23,24,43]. The qualitative part of this study included analysis of answers to five additional questions: three multiple choice questions and two open-ended questions.

The study was initiated before and continued after the start of the coronavirus pandemic. Thus, the research consisted of three stages:

- 1 Before the start of the COVID-19 pandemic (February–early March 2020);
- 2 After 2–2.5 months of the transition to the remote education (end of May–beginning of June 2020);
- 3 After 7 months of distance learning (January 2021).

The study was conducted in accordance with the APA Ethical Standards and the Code of Ethics of the RPS (Russian Psychological Society), and the protocol was approved by the Ethics Committee of RUDN University (# 050422–0–121).

3.2. Participants

The sample included bachelor students of the Peoples' Friendship University of Russia (RUDN University, Moscow, Russia) who studied in the Psychology Department in their second year in the 2019/20 academic year and in their third year in 2020/21 academic year:

- 1 At the first stage: 48 students (39 female and 9 male), aged 18 to 26 (the mean is 20.07 ± 1.47 years);
- 2 At the second stage: 55 students (47 female and 8 male), aged 19 to 23 (the mean is 20.15 ± 1.16 years);
- 3 At the third stage: 53 students (43 female and 10 male), aged 19 to 25 (the mean is 20.91 ± 1.33 years).

The groups of students at different stages of the study coincided only partially: a total of 70 different students (55 female and 15 male) were surveyed, 33 (29 female and 4 male) of them participated in all three stages of the study. All students surveyed were enrolled in the same curriculum and had the same face-to-face and distance learning experiences in 2019/20 and 2020/21 academic years. All students participated in the study during classes in psychological disciplines as one of the additional tasks for which they received additional points. They were advised that participation would be free and voluntary.

3.3. Research Instruments

The *University Students' Attitudes toward DET Questionnaire* was developed by authors based on the analysis of findings of previous research on the use of digital technologies in education [44,45]. We used Cronbach's alpha and MacDonal's omega coefficients and factor analysis for psychometric verification of the structure and internal consistency of this questionnaire [23,24,43]. The final version of the questionnaire includes 21 questions and 4 indicators (some items can fall on two or three indicators):

- 1 "General involvement in the use of DET" indicator characterizes the general interest in DET (12 items, raw scores can range from 2 to 39 points). Examples of the items are: "Do you use social networks to discuss group homework with your classmates?" and "Do you use digital devices in seminars for educational purposes?" (answer options and scores: 0 = almost never; 1 = occasionally; 2 = often; 3 = always);
- 2 "Involvement in the digital space" indicator reflects the activity of using digital technologies in general, not only for educational purposes (8 items, raw scores can range from 2 to 27 points); Examples of the items are: "Do you use social networks to keep up with student news?" and "Do you use the official website of your university?" (answer options and scores: 0 = almost never; 1 = occasionally; 2 = often; 3 = always);
- 3 "The use of digital technologies in education" indicator more specifically reflects the attitude to digital technologies in the educational process (8 items, raw scores can range from 0 to 24 points); Examples of the items are: "Do you borrow textbooks and scientific literature in "paper form" from the library of your university or do you use electronic resources?" (answer options and scores: 0 = borrow from the library; 1 = rarely use literature, in different forms; 2 = something in between; 3 = prefer electronic resources) and "Do you consider it effective to use multimedia presentations in the educational process?" (answer options and scores: 0 = I consider it ineffective; 1 = something in between; 2 = it depends on its quality; 3 = I consider it effective);
- 4 "Digital competence" indicator (4 items, raw scores can range from 0 to 12 points). Examples of the items are: "Imagine the situation: you have received a message from the administration of the institutional mail service that your mailbox has been hacked. To restore it, you are asked to send a password. What would you most likely do in this case?" and "Imagine the situation: you went to a lecture by a famous professor, recorded it on video and posted it on YouTube, and this video was temporarily blocked. Why do you think this happened and what are you most likely to do in this case?". For these items, one correct answer was offered (3 points) and 3 distractors.

This questionnaire was used to measure students' attitudes towards DET at all three stages of the study. At the first stage, the paper-and-pencil version was used, at the second and third stages, data were collected via Google forms: <https://forms.gle/ff3g6ngmqJqpKxjY9> (accessed on 15 March 2022).

At the second and third stages of the study, five additional questions were added to the questionnaire for qualitative analysis of the dynamics of student's attitudes towards DET during the COVID-19 pandemic. The three multiple choice questions were on: (1) the general change in attitudes towards DET after the transition to distance learning, (2) the advantages of DET, and (3) the disadvantages of DET. The two open-ended questions were "What are the main pros of using digital technologies in education, in your opinion?" and "What are the main cons of using digital technologies in education, in your opinion?", the answers to which were further analyzed qualitatively.

3.4. Data Analysis

The descriptive statistics methods, coefficients Cronbach' α and McDonald's ω , and the Mann–Whitney U test for two independent and dependent samples were used for quantitative statistical analysis. Statistical processing was carried out in the R software environment for statistical computing and graphics, version 3.6.1., psych package version 1.9.6 [46]. Percentage analysis and thematic analysis [47] was used for qualitative analysis.

4. Results

Figure 1 and Tables 1–3 present the results of the quantitative part of the study using the *University Students' Attitudes toward DET Questionnaire*. Figure 1 shows that the means of indicators of attitudes towards DET for independent samples (part a) and dependent samples (part b) are almost identical, which indicates their equivalence and gives basis for further comparison of the results of independent samples at three stages of the study.

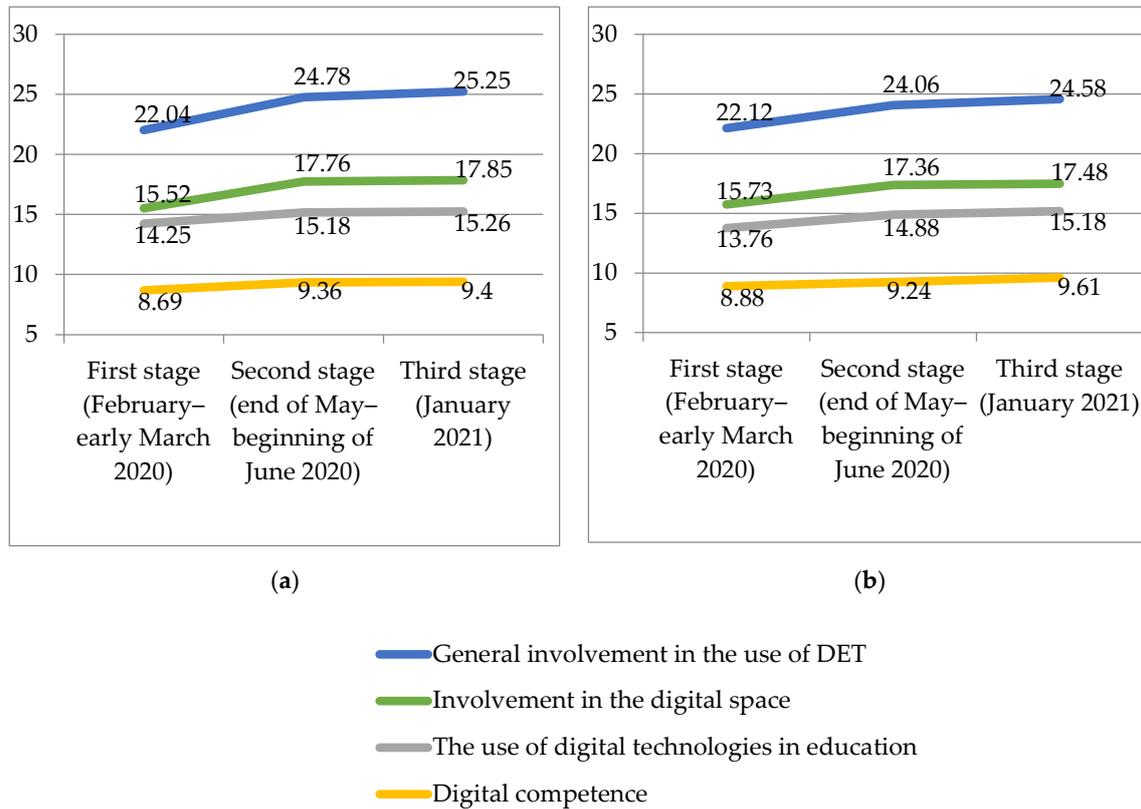


Figure 1. Graphic image of means of the indicators of attitudes towards DET in independent (a) and in dependent (b) samples of university psychology students at the three stages of the study.

Table 1. Means and Mann–Whitney U test for indicators of attitudes toward DET among university psychology students before and 2–2.5 months after the start of the COVID-19 pandemic and transition to distance learning.

Indicators of Attitudes toward DET	Means		Mann–Whitney U Test	<i>p</i> -Value
	First Stage (N = 48)	Second Stage (N = 55)		
General involvement in the use of DET	22.04	24.78	1820.5	0.001 **
Involvement in the digital space	15.52	17.76	1804.0	0.001 **
The use of digital technologies in education	14.25	15.18	1585.0	0.077
Digital competence	8.69	9.36	1566.0	0.097

**— $p \leq 0.01$; *in italic*— $p \leq 0.1$.

Table 2. Means and Mann–Whitney U test for indicators of attitudes toward DET among university psychology students before and after 7 months after the start of the COVID-19 pandemic and transition to distance learning.

Indicators of Attitudes toward DET	Means		Mann–Whitney U Test	<i>p</i> -Value
	First Stage (N = 48)	Third Stage (N = 53)		
General involvement in the use of DET	22.04	25.25	1792.5 **	0.000 **
Involvement in the digital space	15.52	17.85	1707.0 **	0.003 **
The use of digital technologies in education	14.25	15.26	1511.0	0.102
Digital competence	8.69	9.40	1524.0	0.077

**— $p \leq 0.01$; *in italic*— $p \leq 0.1$.

Table 3. Means and Mann–Whitney U test for indicators of attitudes toward DET among university psychology students after 2–2.5 and 7 months the start of the COVID-19 pandemic and transition to distance learning.

Indicators of Attitudes toward DET	Means		Mann–Whitney U Test	<i>p</i> -Value
	Second Stage (N = 55)	Third Stage (N = 53)		
General involvement in the use of DET	24.78	25.25	1549.5	0.570
Involvement in the digital space	17.76	17.85	1447.5	0.951
The use of digital technologies in education	15.18	15.26	1472.0	0.928
Digital competence	9.36	9.40	1447.5	0.949

Figure 1 clearly shows the growth of most indicators of attitudes towards DET at the second stage of the study (2–2.5 months after the start of the pandemic) and their relative stability at the third stage (7 months after the start of the pandemic).

The Mann–Whitney U test for independent samples confirmed significant differences ($p \leq 0.01$) between indicators of “General involvement in the use of DET” and “Involvement in the digital space”, and the trend to differences ($p \leq 0.1$) between indicators of “The use of digital technologies in education” and “Digital competence” at the first and second stages of the study (Table 1).

However, significant differences between these indicators at the second and third stages of the study were not found (Table 2). At the same time, the differences between these indicators at the first and third stages almost coincide with their differences between the first and second stages (Table 3).

An additional percentage analysis of the answers to one of the central questions from the questionnaire (“How do you think digital technology affect the learning process?”) made it possible to see an interesting trend: a decrease in the number of students who believe that digital technologies have a positive effect on education and, accordingly, an increase in those who found it difficult to answer this question (Figure 2).

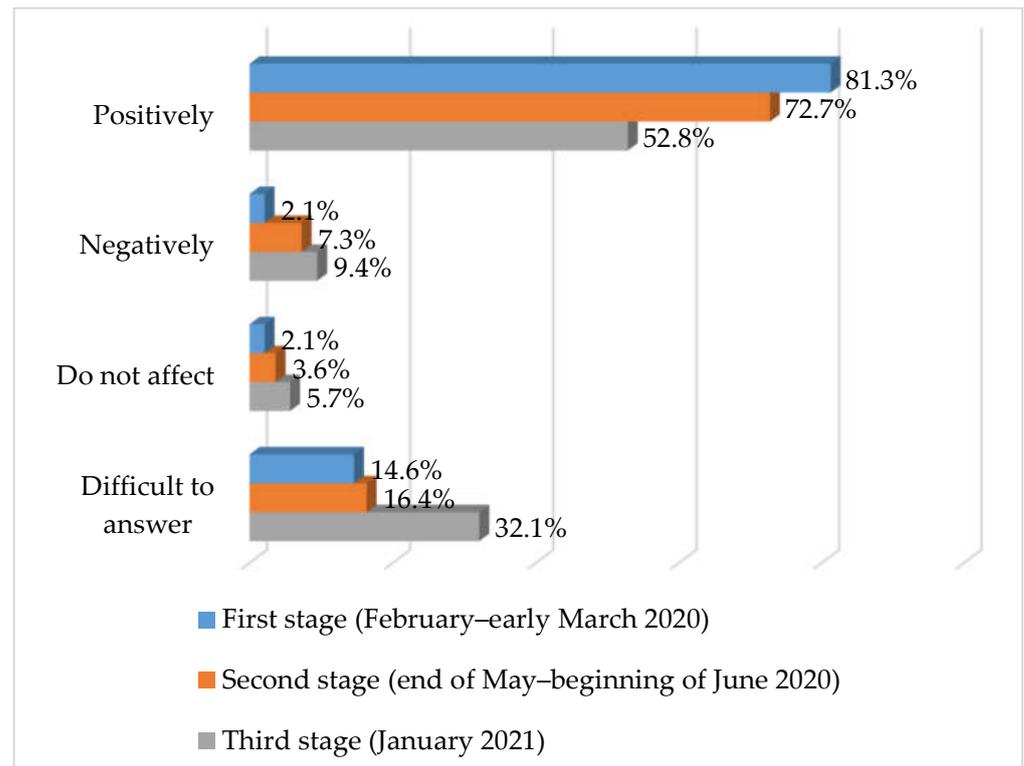


Figure 2. Frequency of answer to a question: “How do you think digital technologies affect the learning process?” (in %) at the three stages of the study.

Table 4 presents the distribution of responses to additional questions regarding students’ assessment of their attitudes and experience of using DET during the pandemic. The percentage analysis shows that over time there was a slight increase in the number of students who have changed their attitude towards the DET for the better and positively assess their online learning experience during this period. It is important to note that both the number of those who believe that “DET has more advantages over face-to-face learning” and the number of those who believe that “DET has more disadvantages over face-to-face learning” have slightly increased.

Table 4. Frequency of answers to additional multiple-choice questions about the experience of distance learning after 2–2.5 months (second stage) and after 7 months (third stage) start of the COVID-19 pandemic (in %).

Questions	Answer Options	Second Stage (N = 55)	Third Stage (N = 53)
“Has your attitude towards the use of digital technologies in education changed with the transition to online learning?”	Yes, for the better	32.7	39.6
	No, it has not changed	40.0	32.1
	Yes, for the worse	16.4	15.1
	Difficult to answer	10.9	13.2

Table 4. Cont.

Questions	Answer Options	Second Stage (N = 55)	Third Stage (N = 53)
“Choose the statement you agree with:”	Distance learning technologies have more advantages over face-to-face learning	20.0	30.2
	Distance learning technologies have more disadvantages over face-to-face learning	30.9	37.7
	Distance learning technologies and face-to-face learning are equally effective	30.9	20.8
	Difficult to answer	18.2	11.3
“How do you assess your e-learning experience gained during the COVID-19 pandemic”	Positively	43.6	47.2
	Negatively	16.4	15.1
	Somewhere in between	38.2	37.7
	Difficult to answer	1.8	0.0

Tables 5 and 6 present the results of a thematic analysis of answers to open-ended questions about the main pros and cons of DET at the different stages of pandemic. It can be noted that over time, the number of students who single out the affordability of learning materials and time savings among the advantages of DET has increased (Table 5).

Table 5. Frequency of answer to open-ended questions “What are the main pros of using digital technologies in education, in your opinion?” after 2–2.5 months (second stage) and after 7 months (third stage) start of the COVID-19 pandemic (in %).

Thematic Categories of Responses	Examples of Responses	Second Stage (N = 55)	Third Stage (N = 53)
Affordability of learning materials	<i>“Necessary information is collected together, always at hand”</i>	27.3	41.5
	<i>“Facilitating access to educational information”</i>		
	<i>“Lecture can be recorded”</i>		
Time saving	<i>“No need to waste time on the road to the university”</i>	23.6	30.2
	<i>“More time for self-development”</i>		
	<i>“More free time”</i>		
Convenience and comfort	<i>“More convenient”</i>	23.6	26.4
	<i>“I’m relaxed, not hungry”</i>		
	<i>“Convenience as you can do it at home”</i>		
Speed and scope of information retrieval	<i>“It is possible to find an answer to any question”</i>	25.5	22.6
	<i>“Easy and fast to find information”</i>		
	<i>“Information search speed”</i>		

Table 6. Frequency of answer to open-ended questions “What are the main cons of using digital technologies in education, in your opinion?” after 2–2.5 months (second stage) and after 7 months (third stage) start of the COVID-19 pandemic (in %).

Thematic Categories of Responses	Examples of Responses	Second Stage (N = 55)	Third Stage (N = 53)
Technical problems	<i>“Sometimes there are problems with the Internet”</i>	23.6	24.5
	<i>“Frequent network or device issues”</i>		
	<i>“There may be technical failures/problems, something may not be saved”</i>		
Difficulties with motivation and self-organization	<i>“Can be distracted”</i>	20.0	13.2
	<i>“Low motivation to complete tasks”</i>		
	<i>“It’s hard to concentrate”</i>		
Lack of “live” communication	<i>“There is no emotional and “live” contact with the teacher and classmates”</i>	14.5	11.3
	<i>“Deprivation of the social component of education”</i>		
	<i>“Sometimes there is a lack of communication and eye-to-eye contact with the teacher and classmates”</i>		
Lack of contact with teachers	<i>“Lectures began to seem less interesting, apparently the personality of the teacher and his non-verbal signals also affect the perception of information”</i>	12.7	9.4
	<i>“No opportunity to speak with teachers in person”</i>		
	<i>“No direct contact with the teacher”</i>		
Potential health risks	<i>“Screen radiation, vision deteriorates”</i>	10.9	13.2
	<i>“Eyes get tired sometimes from the monitor”</i>		
	<i>“Deteriorating health: vision and spine, inactive lifestyle”</i>		
Opportunity to cheat	<i>“A huge opportunity to write off answers, cheat the program”</i>	7.3	11.3
	<i>“Availability in cheating and hack work”</i>		
	<i>“Ability to use cheat sheets”</i>		

Table 6 shows that students’ opinions regarding the main shortcomings of DET at different stages of the study remain relatively stable. Nearly a quarter of the students surveyed cited technical problems as one of the main disadvantages of using digital technologies in education.

5. Discussion

The purpose of present exploratory study was to reveal the changes of the university students' attitudes towards DET before the start of the pandemic and at its different stages with mixed methodology using.

The results of the quantitative part of the study indicate that shortly after the start of the pandemic (2–2.5 months), the involvement of university students in the digital space in general and their involvement in the use of DET in particular increased, but their digital competence practically did not change. Most likely, this is due to the urgency of the transition to distance learning, which did not allow paying attention to the formation of digital competencies of participants. Such results are expected and are quite consistent with the data of other international and Russian studies that after the start of the pandemic, most students adapted to a sharp switch to digital forms of education, despite a number of difficulties [12,14,15,19].

The data of the next stage of our study (7 months after the start of the pandemic) did not show significant changes in attitudes towards DET among the studied students compared with the beginning of the pandemic, although there has been a slight increase in their involvement in the digital space. These results, on the one hand, contradict the results of a study of German students, which showed the deterioration in their attitude towards DET [15], and on the other hand, in general, correspond to the results of a survey of Russian students, which revealed the improvement in their attitude to DET in pandemic extreme conditions [21]. However, a full comparison of the results of these studies is difficult due to differences in sample sizes and diagnostic methods used.

The findings of the qualitative part of the present study allowed us to more fully characterize the change in students' attitudes towards DET during the pandemic. Indeed, most students were positive about their digital learning experiences in 2020, and about a third of the respondents improved their attitude towards DET during the pandemic, while for another third, this attitude remained practically unchanged. At the same time, as distance learning experience is gained, the numbers of students who consider that digital technology to positively affect the learning process decreased. Contradictions between students also increased in the comparison of distance and face-to-face learning: the number of supporters of each of these options slightly increased. We suggest that these differences in attitudes towards DET may be related to the personality and psychological characteristics of students, for example, as shown in our previous studies with their personality traits and academic motivation [22,23].

Thematic analysis of answers to open-ended questions allowed us to highlight the main pros and cons of using digital technologies in education from the point of view of Russian psychology students and compare them with the opinion of university students in other countries based on the literature review.

In the present study, the main advantages of using digital technologies in education listed by most students were: (1) affordability of learning materials; (2) time saving; (3) convenience and comfort while learning; and (4) speed and scope of information retrieval. Moreover, the response frequency of the first two categories increased during the pandemic (as experience in using DET was gained by students). These data are quite consistent with the results of studies of university students in other countries, especially regarding time saving [13,16,24] and comfort [15,16,24]. Russian psychology students in our study paid relatively more attention to the availability and speed of access to educational information; perhaps this is due both to the field of their education [48] and general problems with the implementation of digital technologies in Russian education before the pandemic [36].

Among the disadvantages of technologies listed by university students in our study, as in numerous international studies [12,15–17,24], technical problems are "leading". Indeed, problems with the digital infrastructure of universities, stable Internet access, the availability of digital devices, lack of digital competence of students and teachers, and other issues are among the main restrictions on the use of distance learning during the

pandemic, not only according to students' opinions [12,13,15–17,21,24], but also according to teachers' opinions in different countries [6–8,18]. Other shortcomings of DET that the students from our sample faced during the pandemic (difficulties with motivation and self-organization; lack of “live” communication and of contact with teachers; potential health risks; opportunity to cheat) are also quite consistent with the difficulties identified in international studies [12,13,16,18,19,21,24].

6. Conclusions, Limitations and Future Directions

In summary, the present study offers evidence of changes in attitudes towards DET among university students before and after the start of the pandemic and at its different stages. The advantage of this study is that it was started before the pandemic and was continued after its outset using the same research instrument and in equivalent samples. Such research design allowed us to reveal the dynamics of university students' attitudes towards DET during the transition to distance learning. The research findings indicate that 2–2.5 months after the start of the pandemic and the emergency transition to distance learning, the studied Russian students majoring in psychology significantly increased their overall involvement in the digital space and the use of DET, but their digital competence increased slightly. However, the attitudes towards DET among the studied students remained relatively stable at the next stage of the pandemic compared to its beginning, which may indicate an adaptation to distance learning.

Further analysis revealed that the number of students who positively assessed the impact of digital technology on the learning process decreased with increasing experience in distance learning, although self-reported attitudes towards DET remained relatively stable. We can speculate that as students gain distance learning experience, they better understand both the advantages and disadvantages of using DET, so their opinion about the impact of digital technology on education becomes more balanced.

Qualitative analysis showed that among the main disadvantages of using DET, students, first of all, name technical issues. Technical problems are most often named among the shortcomings of DET at different stages of the pandemic, both by students from our sample and by students and teachers in other Russian and international studies. In our opinion, technical difficulties can arise both for objective reasons and due to insufficient digital competence of students and teachers, which requires further development of special technical support programs for participants in the educational process. Among the main advantages of DET, students in our sample most often cited affordability of learning materials, and the frequency of this response increased as they gained distance learning experience during the pandemic. This advantage of DET is more characteristic of the Russian student sample, while time savings and comfort are among the most frequently cited advantages of DET in both Russian and international studies.

Despite presenting significant results there are several limitations to our study: (1) the sample size and its female-to-male ratio; (2) only psychology students were involved in this study at all of its three stages; and (3) the measure used to collect the data regarding students' attitudes toward DET. The first two limitations are related to the difficulty of conducting a follow-up study during a pandemic. These shortcomings cannot be corrected at the present time; however, the data obtained on the dynamics of students' attitudes towards DET before and during the pandemic can be considered taking into account these limitations.

Regarding the research instrument, the quantitative *University Students' Attitudes toward DET Questionnaire* was developed before the start of the pandemic and supplemented with several qualitative questions after its beginning. We did not change the main questions in order to be able to compare the results at different stages of the study. However, in the near future, we plan to improve this questionnaire, taking into account the sharp changes that have occurred in education over the past 2 years and the new experience of digitalization of learning and teaching.

Therefore, we can conclude that the findings of the present research contribute to the search for social, educational, and psychological factors associated with the effective inclusion, implementation, and use of the digital technologies in contemporary university education. The obtained data will be useful in the development of the psychological support programs for the university students in the educational process using DET during and after the end of the COVID-19 pandemic in order to develop their digital competence.

Summing up all the findings and limitations of our research, we can determine its future prospects: (1) a sample expansion and studying both university students of other fields of study and university teachers of different disciplines; (2) improving the research instrument for diagnosing attitudes towards DET and the use of additional measurement tools for DET; and (3) the development of programs to improve digital competence in university students, taking into account the findings of this research.

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