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ANALYZING USERS' DIGITAL FOOTPRINTS AS A PREDICTOR OF ONLINE LEARNING EFFECTIVENESS

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Abstract. Online education industry has been growing strongly in recent years. The market for educational platforms that provides access to online learning is growing every year. With the increasing growth of online course enrollment, the interest of researchers to study the effectiveness of online learning is increasing. This paper summarizes the results of a study of online courses on the Stepik educational platform. The courses selected for analysis were divided into three groups according to the parameter of learners' "reachability" to the end of training. The process of course completion by 36226 online course participants was analyzed. The main purpose of the study was to identify the factors affecting the yield parameter. The data obtained in the study suggest that the design of online courses does not affect the learning effectiveness and the yield parameter. We attribute such results to the fact that "instructional presence" and "social presence" are almost completely absent in the online learning process, as interaction with the instructor and other learners is minimized. "Cognitive presence" formed through interaction with the educational material is insufficient to form the level of engagement necessary to complete the learning. The study also identified the main points of "falling out" of learners from the educational process and formulated

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the strategies that learners resort to. The obtained data indicate that the parameter of profitability and effectiveness of online learning is most influenced by the qualitative (psychological) criteria of learners. The conclusion of this article suggests the main directions for further research, which can contribute to obtaining more complete data on the factors affecting the effectiveness of online learning.

Keywords: online learning, online learning effectiveness, digital footprints, big data

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Introduction

The events of recent years, primarily the Covid-19 pandemic, have reinforced the global trend towards widespread adoption of digital technologies in the education system. According to East-West Digital News, the volume of the global education market in 2017 was 4.5-5.0 trillion dollars, and the share of online education in it was about 3%, or 165 billion dollars. Analysts predicted that by 2023, the digital part of the industry was expected to surpass the $240 billion mark.

The pandemic has multiplied interest in online learning worldwide: in April 2019, 10.3 million people registered on Coursera, which was 644% more than in the same period of 2018, and the number of educational sessions on the platform during this period increased by 67% to 45 million. In Russia, the demand for online educational resources as a whole increased 3.8 times.

However, the growing interest in online learning does not reflect the issue of the effectiveness of such education. Thus, according to N. G. Valeeva and M. A. Rudneva, only about 10% of students enrolled in an online course complete the training until the end [1]. The question of the quality of the achieved educational results remains open.

The effectiveness of learning can be considered as a measure of coincidence of actually achieved results with the stated goals of the educational program. According to D. Kirkpatrick's classical model of training effectiveness assessment, it is measured by the following criteria: 1) the attitude of the learner to the program; 2) the level of mastering the program materials; 3) the degree of using the acquired knowledge in practical activities and 4) the results of employee training for the organization itself [32]. The question of whether the classical model can be used to assess the effectiveness of online learning remains debatable: a number of authors believe that the effectiveness of online learning cannot be measured by the same criteria as traditional learning [19].

There are studies that have proven that there are no significant differences between the effectiveness (learning outcomes) of students who took courses online or traditionally [24, 27, 18]. Brown and Liedholm [14]; Cheng et al. [16], on the contrary, argue that online learning lags behind traditional learning in its results.

According to R. Clark, the main influence on learning outcomes is not its mode (traditional/online) - it is just a way of knowledge delivery - but the design of the training course [20]. G. Salomon argues that course design for online/offline learning should be different [40].

According to P.L. Pecker, the evaluation of the effectiveness of online courses can be carried out according to quantitative (the ratio of those registered for the course and those who successfully completed it, score evaluation of results, the number of listeners who viewed at least one course material, etc.) and qualitative (motivation of listeners in the learning process, the goals of listeners and their achievement in the process of studying the program, the degree of involvement in discussions) criteria [11].

K. Swan [44] considers the category of "interaction" as the central category that determines the effectiveness of learning; for online learning it is the interaction of the learner with the content, interaction with the teacher and interaction of learners among themselves. The three types of interaction create the "presence effect" in the e-learning environment, the lack of which is considered as a factor in reducing the effectiveness of online learning [2].

On the axis of learner interaction with content, "cognitive presence" is created, learner interaction with each other forms "social presence", and interaction with the instructor forms "instructional presence".

S. Eom and N. Ashill supplementing the proposed model, in addition to the quality of course design, the figure of the teacher, the possibility of dialog between students and teacher-student dialog, introduce personal variables of motivation and self-regulation of students [22].

Recently, in studies aimed at identifying factors that can be used for educational management, investigating students' social networking behavior has developed a model to make predictions about their academic performance.

The actual study sought to determine the extent to which online course design influences the rate of "yield," i.e., complete course completion by the learner.

Materials and methods of research

Achievement of the research objective was based on the use of modern methods of collecting, processing and analyzing digital data - Data Mining. Data Mining methods were used to obtain data on the digital footprints of online course users on the Stepik educational platform. The Stepik platform is an educational platform that hosts more than 25,000 online courses that allow not only to learn and improve skills, but also to take part in competitions and Olympiads.

Numerical traces related to the behavioral patterns of online course attendees were used as input data. In the course of the study, data from 36226 students of 15 courses were uploaded, containing information about the number of viewed course elements, completed control tasks, academic performance (points scored for each control element of the course), and the result of course mastery.

Since we tested the hypothesis that course design is related to the level of engagement, which can be conventionally measured by the number of successfully completed courses (the "reach" criterion), it was decided to compare the behavioral characteristics of course users significantly different in terms of the "reach" criterion. We identified 5 courses with low yield (bottom) - average yield of 1.5% of learners, 4 courses with medium yield (middle) - average yield of 25% of learners and 6 courses with high yield (top) - average yield of 45%. The following indicators were used as criteria for characterizing the course design: the number of test elements of the course, test assignments, the presence of video lectures, and the presence of the text of the lecture material. In the process of analysis, user data were anonymized.

Analysis and discussion of the results

The primary results of the analysis are presented in Table 1. As follows from the data obtained, the structure of the educational course itself does not have a significant impact on the percentage of yield of trainees:

- the number of test and control assignments practically does not affect the number of those who successfully completed the course: among the courses we analyzed there were courses with a large (531) and a small (15) number of test items, and the percentage of yield in them practically did not differ: the course with 531 test items had 38% yield, the course with 15 test assignments - 37.5%.
- The quality of the course content (specifics of content presentation) does not significantly affect the yield percentage, we did not find any differences between courses containing video lectures or only textual explanations.

The results obtained agree well with K.Swan's model. The courses posted on the Stepik platform practically do not involve direct interaction between learners and the teacher, who appears only at the control stage, and the possibility of communication with him is limited, which does not allow the formation of the effect of "learning presence", there is no possibility of interaction between users, as they have access only to general chats, but they take the course at a different pace, so the effect of "social presence" is not formed. The learning content itself, which is responsible for the "cognitive presence" is clearly not enough to create the level of engagement necessary to fully complete the training.

That is why in the current conditions the factors determining the effectiveness of training are qualitative criteria, i.e., psychological characteristics of the learner himself.

Table 1. Results of the analysis of user behavior of top, middle, bottom category courses

№	Title	Number of students	Completed	Abandoned	Number of course elements (video text)	Number of test items	Didn't pass a single element	Drop-off points
Top								
1.	MOVE_ Business Communication	1973	751 (38%)	1222 (62%)	87	531	119 (9.7% of departures)	First element of the course - 698 (57.2% of dropouts)
2.	Medical and social research_ basics of statistical analysis	1630	897 (55%)	733 (45%)	211	133	128 (17.4% of departures)	First element of the course - 271 (37% dropout rate) Eighth element of the course - 37 (5% dropout rate)
3.	Designing digital educational products	810	361 (44,6%)	449 (55,4%)	76	26	74 (16.5% of departures)	First element of the course - 225 (50.1% of dropouts) Second element of the course - 26(5.8% of dropouts)
4.	Russian language_ scientific style of speech, biomedical profile	1595	427 (26,8%)	1168 (73,2%)	71	161	171 (14.6% of departures)	First element of the course - 354 (30.3% of dropouts) The second element of the course was 122 (10.4% dropout rate) Third element of the course - 50 (4.3% of dropouts)
5.	Modern digital technologies for the service sector	1396	523 (37,5%)	873 (62,5%)	28	15	117 (13.4% of departures)	First element of the course - 566 (64.8% of dropouts) Second element of the course - 47 (5.4% of dropouts)
6.	Managing Digital Transformation. Project approach	6626	4698 (71%)	1928 (29%)	91	44	413 (21.4% of departures)	First element of the course - 600 (31.1% of dropouts) The second element of the course was 101 (5.2% dropout rate) Third element of the course - 107 (5.5% of dropouts) Tenth element of the course - 137 (7.1% of dropouts)

№	Title	Number of students	Completed	Abandoned	Number of course elements (video text)	Number of test items	Didn't pass a single element	Drop-off points
Middle								
7.	Information technologies in the hospitality industry-Information technologies in the hospitality industry	866	216 (25%)	650 (75%)	84	149	88 (13.5% of departures)	First element of the course - 290 (44.6% of dropouts) Second element of the course - 43 (6.6% of dropouts) Third element of the course - 44 (6.8% of dropouts) Eleventh element of the course - 39 (6% dropout rate)
8.	PR, marketing and personal brand	3220	913 (28%)	2307 (72%)	44	17	273 (11.8% of departures)	The first element of the course was 1,192 (51.7% of dropouts The second element of the course was 200 (8.7% dropout rate) Third element of the course - 154 (6.7% of dropouts)
9.	Project management. From theory to practice	3541	1055 (30%)	2486 (70%)	45	32	332 (13.4% of departures)	First element of the course - 1176 (47.3% of dropouts) The second element of the course was 116 (4.7% of dropouts)
10.	Finance for your personal and business growth	1444	388 (27%)	1056 (73%)	26	16	162 (15.3% of departures)	First element of the course - 679 (64.3% of dropouts) The second element of the course was 62 (5.9% dropout rate) Third element of the course - 47 (4.5% of dropouts)
Bottom								
11.	Parametric Designs in Revit Parametric Designs in Revit	2788	39 (1,5%)	2749 (98,5%)	103	82	1148 (41.7% of departures)	First element of the course - 1316 (47.9% of dropouts)

№	Title	Number of students	Completed	Abandoned	Number of course elements (video text)	Number of test items	Didn't pass a single element	Drop-off points
12.	Plant Protection	3768	76 (2%)	3692 (98%)	45	150	125 (3.4% of departures)	First element of the course - 2012 (54.5% of dropouts) The second element of the course was 187 (5.1% dropout rate) Sixth element of the course - 355 (9.6% dropout rate)
13.	Sedimentary Petrology Sedimentary Petrology	2628	42 (1,6%)	2586 (98,4%)	417	244	1190 (46% attrition rate)	First element of the course - 1,264 (48.9% dropout rate)
14.	Fundamentals of structural dynamics using Python	1351	16 (1%)	1335 (99%)	143	151	883 (66% attrition rate)	First element of the course - 389 (29.1% of dropouts)
15.	Strategies for standardization and sustainable development	2590	16 (0,6%)	2574 (99,4%)	71	133	123 (4.7% of departures)	First element of the course - 1407 (54.7% of dropouts) The second element of the course was 133 (5.2% dropout rate) Third element of the course - 172 (6.7% of dropouts)

In the course of data analysis, the main points of "drop-out" of trainees from the educational process were identified. As can be seen from Table 1, up to 50% of "losses" occur after familiarization with the first element of the course. This trend in each of the three analyzed groups. The second and third elements of the course are the next most pronounced "drop-out" points in the three groups.

Based on the analysis of the online course process, the following behavioral strategies were identified by the trainees:

1) "Honors" - Pass every element of the course and complete every test assignment.

2) "Accelerated learning" - trainees may skip some theoretical elements of the course and optional test tasks, but perform all mandatory and final tests in order to complete the course and receive a certificate. The number of attempts at passing test elements in such students is higher than in "excellent" students, which is obviously due to insufficient immersion in theoretical material and solving some test tasks at random.

3) "Previewing" - with this strategy, students most often do not complete the course. As a rule, they review the first element of the course, then move on to different theoretical blocks, review one or two elements and move on. Among the representatives of this category there are those who finish the course and get a certificate, they ignore the intermediate forms of reporting, but pass the final testing required to get a certificate. This behavioral strategy may be related to the desire to evaluate the degree of usefulness of the course.

4) "First element" - listeners who drop out of the course after being introduced to the first element. This behavioral strategy assumes that regardless of the content of the first element (text, introductory video with the course description) the listener will not continue the training. As the results showed, up to 50% of the users enrolled in the course will demonstrate this behavioral strategy.

These results are in agreement with the opinion of S. Eom and N. Ashill, as well as R.V. Ershova [5], that the determining criteria for the effectiveness of online learning are qualitative criteria related to the user's personality, which may include motivation and specificity of self-regulation.

It should be noted that despite the fact that the study was a pilot one, it revealed some trends that can be used in the creation of online courses: only quality content is not enough to ensure a good "reach", it is important to create a "learning" and "social" presence in the listeners, for example, through the use of a chatbot acting as a teacher, the creation of chat rooms for the learners themselves.

Important issues are the formation of motivational involvement, filtering students by their motivation level "at the entrance" to the course, creating opportunities for a more informed choice of content and direction of training.

Further research in this direction can be related to the study of the relationship between the specifics of the digital platform itself (paid/free, focused on the formation of practical skills, career change (Skillbox, Skillfaktory, GeekBrains)/ general education, focused on self-development (LevelOne, Art for introvert)) and the level of effectiveness of online learning.

Another area of research is the study of factors related to the trainee's personality: digital competence of trainees, level of motivation, individual characteristics of cognitive processes, emotional involvement, self-control, self-regulation, and others.

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