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Cognitive and technological aspects of e-learning in context of robotization

Abstract. The development of e-learning education led to the emergence of two main problems of such form of education, which are the user-system interaction from the cognitive prospective, and the analysis of massive data received out of students' activity. The development of artificial intelligence concepts and robotic process automation (RPA) tools, both problems might be solved in a more efficient way. The article presents the intelligent system of feedbacks, realized as JavaScript extension to Moodle platform, which intends to strength cognitive output of the performed learning activity, creating an illusion of the trainer's presence and, therefore, contribute to the resolution of the first problem. The resolution of the second problem is proposed using artificial intelligence worker built in Blue Prism RPA platform, which independently collects test results and runs an Excel macro, which performs validation of test questions upon strict criteria of selection. Such validation process allows to select the questions which are coherent with the index of complexity and the index of differentiation capacity.

Key words: intelligent system of feedbacks, robotic process automation, artificial intelligence worker, Blue Prism automation.

We are gradually moving from the information society to a cyber society, characterized by increasingly rising role of robotics in the society organization, which penetrates to all spheres of human activity: industrial, agricultural, cultural, educational. According to forecasts of analysts in the USA, 47% of jobs related to the repetitive work are at risk of disappearance due to robotization in public and private sectors (Frey, Osborne, 2016). The previous society transition from an industrialization phase to an informatization phase forced workers out of a production sphere into a sphere of human service. The contemporary process of the society transition from the informatization phase into a cybernetic phase displaces work force *from the sphere of human service* to *the sphere of servicing robots* and the most demanded in the nowadays labor market are the specialties related to the robotics, namely: electronic engineers and software engineers.

These processes occur in parallel to rapidly increasing information flow. The speed of the new professional, scientific and technological information appearance is so high that traditional methods of training can no longer perform the function of preparing a qualified specialist for the labor market if they are not complemented by informational forms of learning, in particular, e-learning (Siemieniecki, 2007). A distance learning, the idea of which appeared in the end of the twentieth century, has become very widespread due to the emergence of the Internet (Morbitzer, 2017) and software-tool platforms. Nowadays we are witnessing a new stage in a distance learning development, related to the emergence of smartphones and the development of mobile applications, so that distance learning *comes off the computer screens* and *goes to the screens of mobile phones*. In a changing information society, the teacher is forced to constantly learn and acquire new skills of working with the emerging new learning programs and tools (Karwasz, Karbowski, Rochowicz, 2014). The role of the teacher also changes: the teacher is no longer the source of knowledge; he/she becomes the coordinator of the knowledge acquisition process performed by a student himself. The pedagogical system, which used to consist of a teacher and a student, now has three components: *a teacher, an e-learning platform, a student.* The appearance of this third component – e-learning platform, in the pedagogical system, deeply influenced the teacher specialization and led to the emergence of new platform-related specialties, such as a teacher-administrator of e-learning platform, a teacher-developer of e-courses, a teacher-user of electronic courses. Finally, the need in learning content development for mobile devices has resulted in the appearance of a teacher-web-developer specialization.

The deployment of information technologies in e-learning platform features amelioration allows the student to benefit from the increased system responsiveness, which immediately analyses the student's weakness in knowledge acquisition and proposes the relevant material to clarify the cognitive associations. Such a feedback-oriented intelligent system is the first focus of the article. The second focus is made on robotization of teacher's repetitive activity, which frees the teacher from the routine work on tests data processing and provides the opportunities to emphasis his/her attention to the teaching strategies amelioration, using the concise output received out of the processing robot, built using modern Robotics Processes Automation (RPA) tools and methods.

Before considering the functionality of above-mentioned information products, let us emphasis the cognitive features of teaching inherent to the modern state of pedagogical development, comparing them to the theories existing in the pre-information era (Shvets, 2015, p. 37–43).

According to well-known psychological theories (I.P. Pavlov, I.M. Sechenov), training should base on initial activation of the first-signal system, responsible for impressions and imagery, in order to launch the second-signal system devoted to the logical thinking. A handful of programs allow to connect visualization, sound, motion, make 3D imagining, however the use of those technical possibilities should comply with a measure of exposure of these factors on a person's consciousness. The authors of many e-courses provide the possibility to turn off the sound, video, animation, etc., however this is not the best solution to the problem, since the need for permanent disconnection interferes with concentration on educational material.

The e-learning platforms allowed a transition from an association-based approach of teaching to an activity-based approach, the theoretical bases of which were developed back into the 20th century (Piaget, 1994; Galperin, 2008). Along with many technical possibilities, provided by e-learning systems, a new problem of communication between student and a virtual learning environment has appeared. One of solutions introduced an anthropomorphic teaching object appearing on the screen of a monitor intended to increase the level of cognitiveness of the studied educational material (Shvets, 2015, p. 37–43).

The intensive development of neuroscience has broadened the boundaries of ideas about the human brain, which is seen as a computer, interpreting and storing in a memory received input information from the external environment (Miller, 2003). With this approach, the learning process can be algorithmized and, as a consequence, robotized. Excellent opportunities for such learning process robotization are provided by the software-tool platform MOODLE.

MOODLE is built using open key coding, which allows connecting additional software modules to the platform. The program module, written in Java Script (programmer O. Vetchinkin), was connected to the platform for conducting training testing while creating the author's electronic resource "Electrical engineering with the basics of industrial electronics" for vocational education. The methodology of the training testing was based on the algorithm for solving the problem, in which each step of the algorithm was controlled by a software-tool platform. In case of the correct answer, the platform was giving a positive evaluation and proceeded to the next step of the algorithm. In case of incorrect answer, the platform was giving a comment in which it analyzed the reason for the incorrect response and was redirecting the student to the training module with the learning material necessary to the correction of decision in a giving algorithmic step. Only after reading of this particular module and giving a correct answer, the platform allows the student to proceed to the next step in the problem solution (Shvets, 2015, p. 107–117).

In the process of such learning testing, an illusion of communication with the instructor is created, although in reality the student communicates directly with the software-tool platform. The presence of the teacher is manifested in an *indirect way*, namely: in the skillful creation of the algorithm for solving the problem, in adequate comments, in qualitative methodological assistance at each incorrectly solved step of the algorithm. It should be noted that the platform provides opportunities for *direct* communication between the teacher and the student in synchronous and asynchronous chat, which are a good addition to the training testing, expanding the capabilities of the software-tool platform.

The intensive process of the society robotization poses a new problem in e-learning education: the problem of automating the process of creating valid tests and the process of interpreting control results (especially for large groups of students). Test questions are called "valid" when a precise selection, based on a specific algorithm, is done and only questions, which are neither too easy nor too hard, are left, becoming the tool for adequate knowledge measurement. The procedure for creating valid tests is based on the laws of statistics and is defined in the normative document of the Ministry of Education of Ukraine (1998). The algorithm for determining valid tests for dichotomous testing consists of the following steps:

- in the first step, a table of students' answers is created for each of the test questions;
- in the second step, the table is ranked according to the results of students' answers: from lowest grades to highest grades;
- in the third step, the table is ranked according the answers to each test question: from the questions with the greatest number of correct answers to the questions with the lowest number of correct answers; questions, which got the same number of correct answers are eliminated if they belong to the same topic;
- in the fourth step, the twice ranked table is divided into three equal parts: at the top, a group of students with weak knowledge is placed; a group of students with strong knowledge acquisition is placed in the bottom; if the number of students cannot be divided into three equal parts, the weak and strong groups should count the same number of students and a reminder is added to the middle part;
- in the fifth step, the middle part is eliminated;
- in the sixth step, the number of correct answers for each question in a strong group of students (H) and in a weak group of students (L) is calculated;
- in the seventh step, the indices of complexity (I_c) and differentiating ability (I_d) for each question are calculated according to the formulas:

$$I_c = \frac{H+L}{N} \cdot 100 \quad (1)$$

$$I_d = 2 \cdot \frac{H-L}{N} \quad (2)$$

As we can see, the manual performance of all those steps might be very laborious, therefore, let us consider how the automation of this process might be done using the commercial Blue Prism software and Robotic Process Automaton methodologies.

Blue Prism is a commercial product created by Blue Prism Group, a world pioneer of robotic process automation. Blue Prism is capable to interact with Graphical User Interface (GUI) elements of software, running on a desktop or in web-browser. The interaction is possible after the recognition of GUI elements is made in application modeler. These elements are stored in a Business Object, which is further used in a Business Process. Blue Prism either launches or establishes a connection with an application, then, using the GUI elements modelled in the Business Object, performs the actions described in the Business Process. If the interaction should be made with more than one application, process should use an additional Business Object launching or connecting to the additional application.

In our case, the launching of two applications will be made: first, the Business Process will launch Internet Explorer with the link to the MOODLE platform in order to download the sheet with students' grades, and then it will launch Microsoft Excel application and run a macro, performing test validation steps. The output will be written in a dynamically created Excel sheet inside the workbook. The input data will be taken from the entry MOODLE test on music theory performed by Anna Shvets with students of Music Faculty of Bordeaux University in 2014 (Pistone, Shvets, 2014, p. 107–112).

Let us take a look at the created Business Process. The main page contains the main flow of actions, which are given as visual shapes, called "page stages" with the references to other pages of the Business Process (fig. 1) – each page contains the detailed steps performed by Business Process: login to MOODLE platform, navigate to the report with students' grades and download it, convert initial file with .csv extension to .xlsx extension, which allows running macro, and run the macro itself.

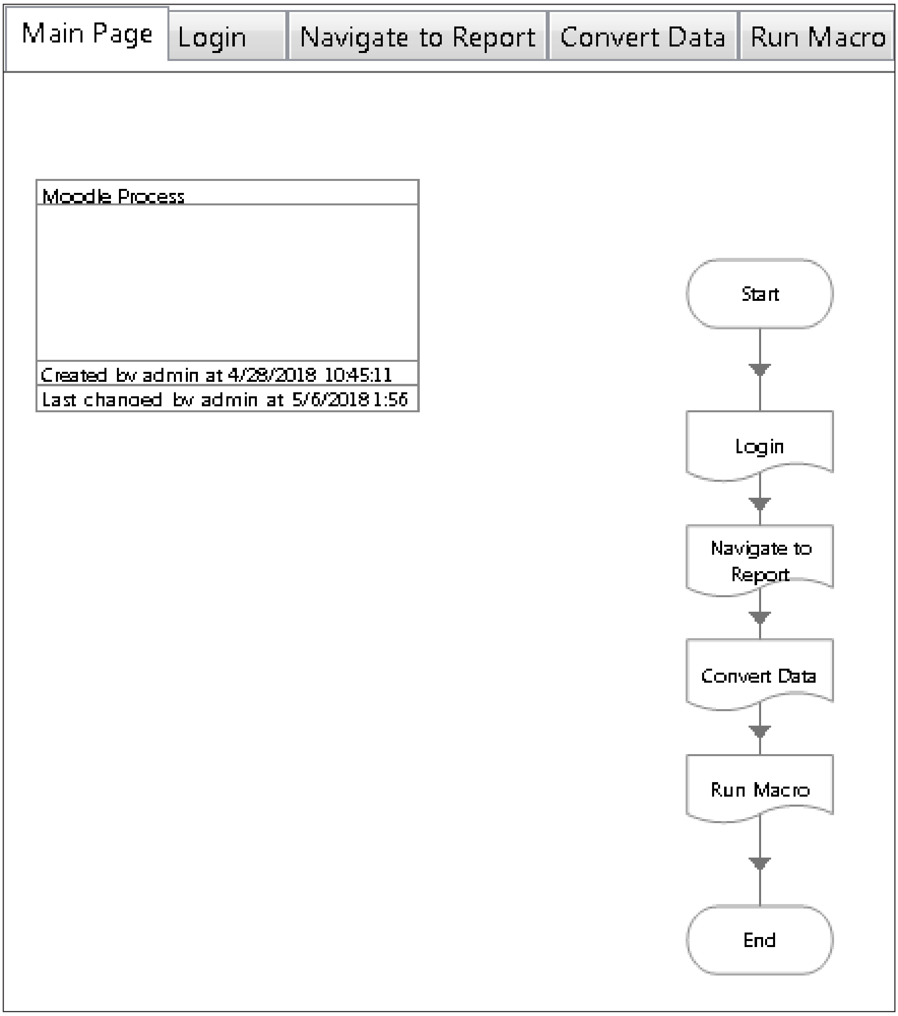

Fig. 1. Main page of the Business Process in Blue Prism

Each of above-mentioned pages consists of detailed steps, presented in a form of action stages, which evoke the functionality provided by a specific model from Business Object (fig. 2).

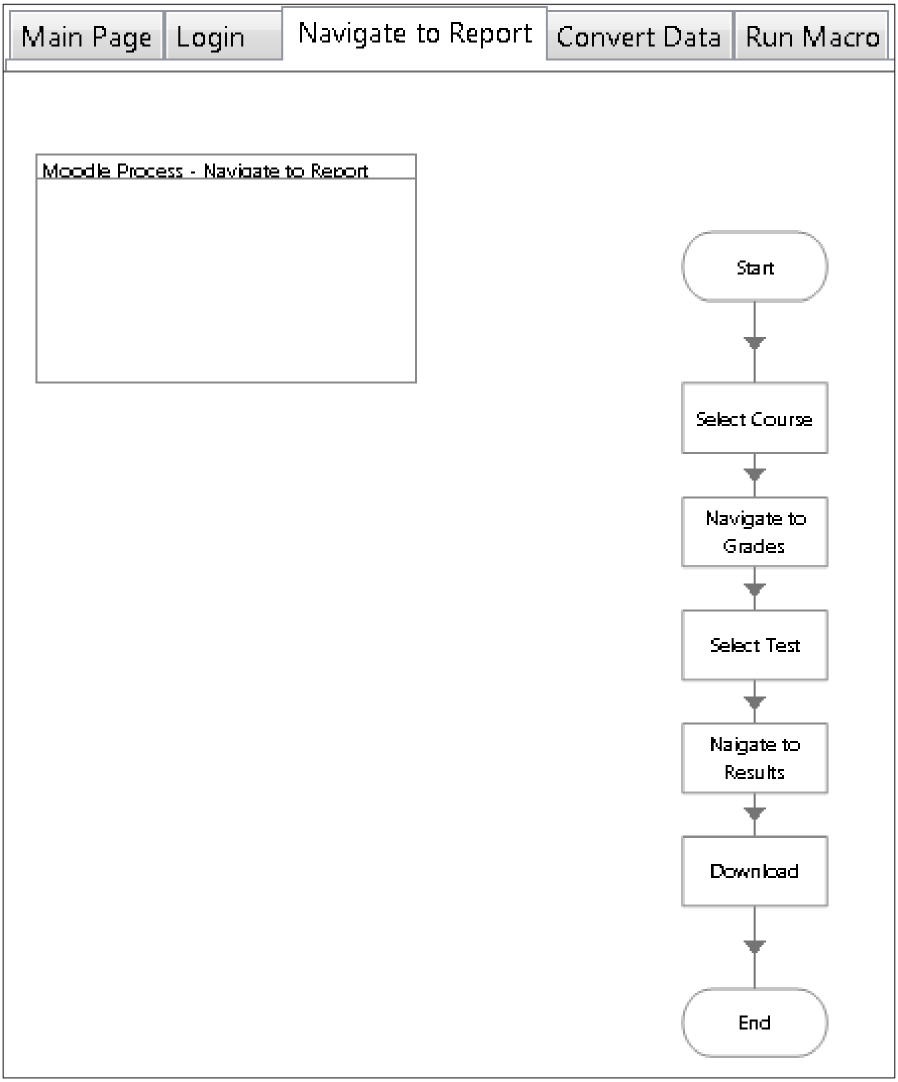

Fig. 2. Navigate to Report page of the Business Process in Blue Prism

The Business Object, referred in the Business Process consists of yet detailed actions, separated into multiple pages, which are not linked between themselves. The Business Object is capable of retrieving the values from a specific input field with aid of the read stage, as well as filling in the input field with the specific information from data items floating aside the logic of steps execution; it might also choose a specific item from a drop-down list of items, check of uncheck the checkbox [fig. 3]. On the example below the Business Object reads the value of the modelled GUI element and stores it in a data item with the name “Value from Language Panel”, then it compares this value to the value given in “Language” data item: if the values differ, then Business Object chooses the required language, if the value is already correct, it bypasses the logic of choosing and finishes the step in the “end” stage.

After running all the steps from the Business Object downloading input data from MOODLE, the Business Process launches Excel application, using internal BO Business Object and performs a file conversion by opening the downloaded .csv file, transposing it to a Blue Prism collection, and writing the data into a file with .xlsx extension [fig. 4]. It should be noted, that the initial data are filtered in the loop, iterating through each row of the input collection: only the fields from columns containing useful information for the test validation process are transposed to the output collection, which is then written to a file with .xlsx extension.

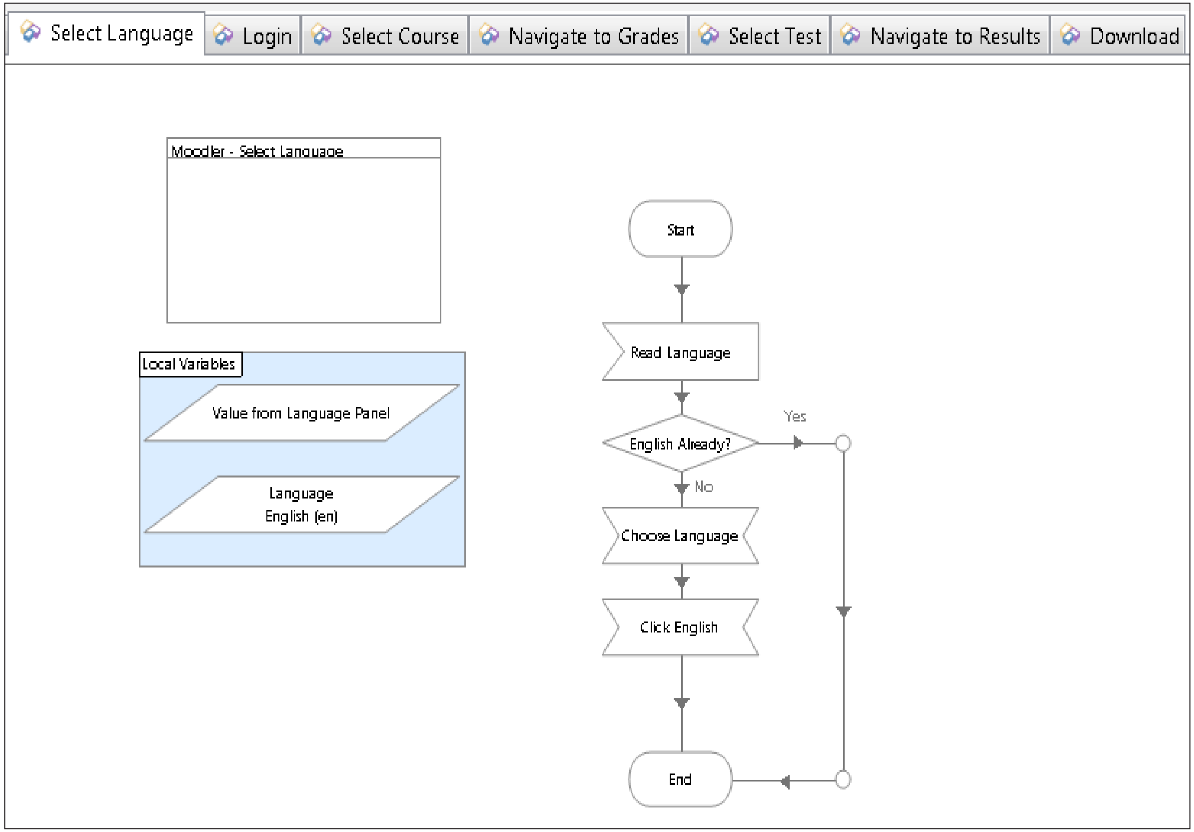

Fig. 3. Select Language page from Business Object in Blue Prism

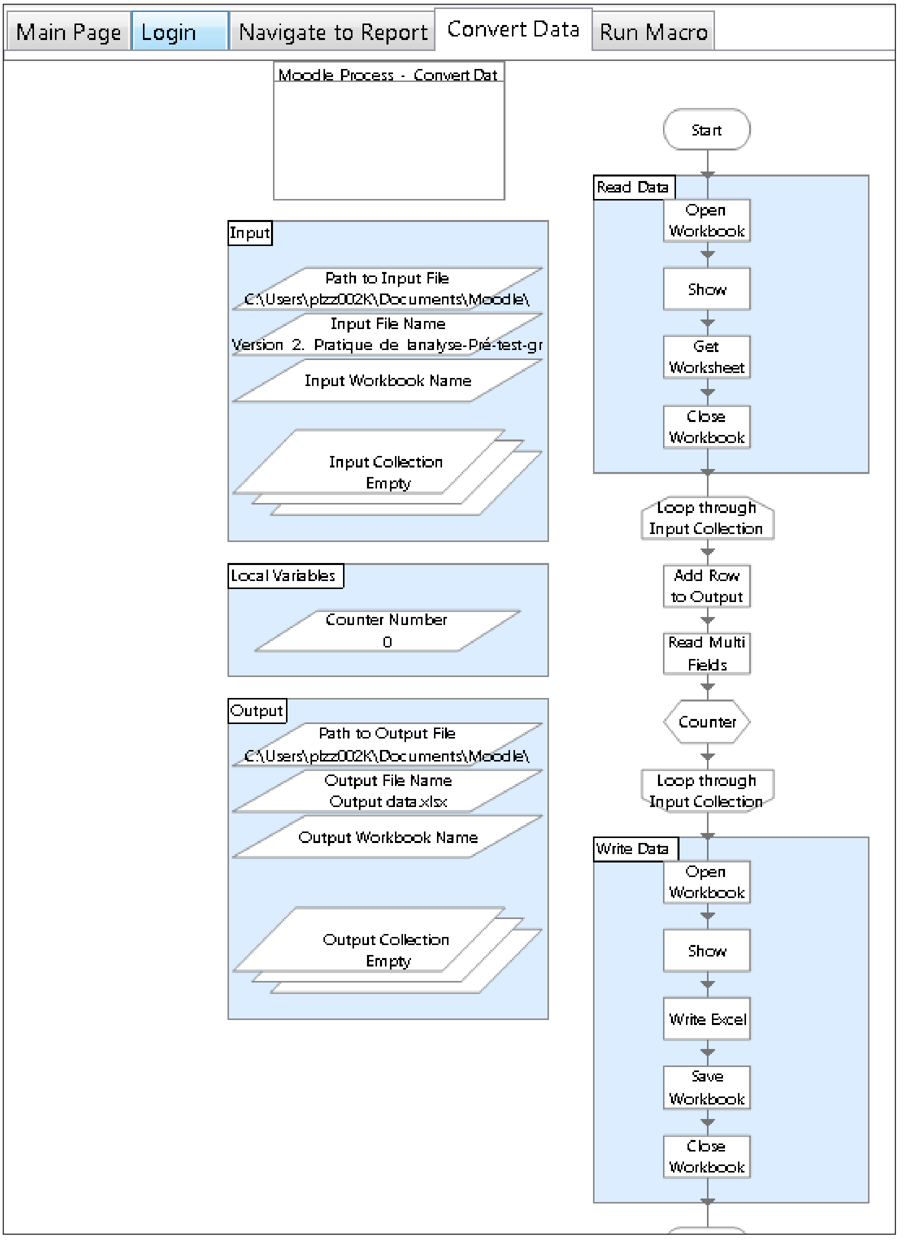

Fig. 4. Convert Data page from Business Process

When the filtered data are saved to Output data .xlsx file, the last page of the Business Process runs the macro, written in Visual Basic programming language. The output of the macro is written to the Sheet2 of the workbook were the filtered data were stored by Blue Prism. From the marco output we can see that only 4 questions out of 10 passed validation according the *L* and *H* groups with *Ic* and *Id* indexes for each question [fig. 5]. This result is statistically correct and is valid for larger data.

Surname	Question 5	Question 1	Question 4	Question 10
Planchot	0	1	0	0
arriaga	0	1	0	0
Bernard	1	0	0	1
Alicia	1	0	0	0
Guillemoto	0	0	1	1
Thezan	1	1	0	0
L	3	3	1	2
Louis	1	1	1	1
Louis	1	1	1	0
auriane	1	1	1	1
Berlon	1	1	1	1
Bessière	1	1	1	1
Léah	1	1	1	1
Ricaud	1	1	1	1
H	7	7	7	6
Ic	45.45454545	45.45454545	36.36363636	36.36363636
Id	0.363636364	0.363636364	0.545454545	0.363636364

Fig. 5. Marco output table

Conclusion

Modern software languages (JavaScript) and software packages (Blue Prism) allow solving such cognitive tasks of e-learning as the algorithmization of e-learning and e-control and the robotization of results processing.

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