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**Project of a personal educational platform to support personalized learning of high school students<sup>1</sup>**

**Abstract:** The development of a system for designing the transition to personalized learning in Kazakhstan is an important direction for the development of innovations both in the field of information technology and in the field of school education, taking into account the instability of the external environment (the situation with the Covid-19 pandemic). This article presents a project of a personal educational platform to support personalized learning of high school students, based on the author's conceptual model of the introduction of this type of education in schools of the Republic of Kazakhstan. The architecture of the personal educational platform is developed, subsystems and microservices are described, and the algorithm of the platform operation is proposed.

**Keywords:** design system, information technology, personalized learning (abbreviated – PL), conceptual model, personal educational platform, architecture

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**2000 Mathematics Subject Classification: 68M99**

## 1. INTRODUCTION

In the modern world, in the era of globalization, the education systems of all countries are undergoing significant changes. This is primarily due to the rapid development of digital technology and new living conditions during various natural disasters, a vivid example of which is the Covid-19 pandemic [1, 2].

Kazakhstan at this stage of the development of the education system has felt the full range of problems associated with the massive transition to distance learning: a decrease in the quality of students' knowledge in online learning, difficulties in the implementation of differentiation and individualization of learning, a weak level of self-regulation and self-learning skills of students, insufficient level of digital competence of both students and teachers, insufficient quantity of high-quality educational resources and the lack of an effective digital electronic platform. And this is an incomplete list of problems. Nevertheless, the Ministry of Education and Science of the Republic of Kazakhstan was able to develop and implement such educational portals as iMektep in a short time.kz, Bilimland.kz, Twig-bilim.kz Zhastar.org, Audiokitap.kz, Openu.kz, Academia.kz and others. These resources helped teachers to organize the online learning process and partially support differentiation by choosing different types of tasks [3]. State education programs were also aimed at digitalization of the education system in new conditions [4, 5]. But nevertheless, there is a problem of rational organization of the educational process through a personal educational portal that will be able to cover the needs and interests of students and take into account their personal characteristics when selecting educational routes.

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An analysis of existing electronic platforms has shown that most of them are paid and do not contain the necessary functions for personalizing learning [6–11]. The platform should be technically easy to implement, intuitive and understandable to all users (teachers and students in the first place) and based on artificial intelligence offer a personal educational route of the student, according to his profile. A personal educational platform should also build a strong educational community with the ability to exchange opinions and develop digital competencies of students, giving them an understanding of how modern artificial intelligence works.

In this regard, the School of Information Technology and Information Systems on the basis of the EKTU named after Serikbayeva and Nazarbayev Intellectual School of Ust-Kamenogorsk set the goal of creating a conceptual model for the introduction of personalized learning in schools of the Republic of Kazakhstan and on its basis developing a personal educational platform for high school students that meets the above-mentioned modern requirements of personalization of learning.

## 2. RESEARCH METHODOLOGY

The methodological basis of the research is the methods of system analysis and knowledge management. The logical-structural method was chosen as the basis for creating a conceptual model for the implementation of personalized learning with the support of information technology. The article reflects the results obtained by the authors in the process of developing a prototype of a personal educational platform based on the East Kazakhstan Technical University named after Serikbayev.

## 3. THEORETICAL JUSTIFICATION

### CONCEPTUAL MODEL OF PL IMPLEMENTATION WITH INFORMATION TECHNOLOGY SUPPORT

The personalization of educational policy, methodology and practice is considered in the studied resources as an important path for the development of higher education, which leads to the formation of an important value of "Lifelong Learning". In the works of the founders of this idea (E. Munier, A.V. Petrovsky, V.A. Petrovsky), individual personalization is considered as a process and as a result of which the subject receives an ideal representation in the life of other people and can act in public life as a person [12, 13]. According to V.V. Gracheva [14], the essence of personalization lies in the effective transformations of the intellectual and affective-need sphere of another person's personality, which occur as a result of the individual's activity. Research by Yu.V. Krupnov [15] shows that personalization as a process is realized through the development of personal strategies, their implementation in actions, and ultimately reflection on their own work results. The most famous foreign researchers include F. Miller (development of methodological foundations, including the stages of building the process of remote learning), P. Brusilovsky (development of distance learning systems, creation of a student model for an adaptive learning system). The theory of personalization is also present in the foreign modern concept of connectivism, developed by J. Siemens and S. Downes [16, 17]. The process of personalization in the system of this concept is considered as the formation of a dynamic network of information connections and orderly relationships in a changing environment that is not completely under the control of the individual. If we consider the process from the outside, then the student must have a real or virtual communication network in the educational community. He should set goals for his activities, actively apply his knowledge in various disciplines in practice, where they could communicate with each other, etc.

Depending on the technologies and teaching methods used, various forms of personalized learning are distinguished. In this table, four types can be considered: expansion of student autonomy, self-education, differentiated learning and adaptive learning (Table 1).

Dan Buckley also identified two areas of personalization of learning: personalization of the program, when the training adapts to a specific listener, and personalization by the learner himself, when the listener independently builds his training [18]. The chosen form of personalized learning allows you to build an individual learning trajectory of the student [Figure 1].

TABLE 1 – Forms of personalized learning

Forms of PL	Explanation
Differentiated learning	The division of students into groups / categories, for each of which, taking into account the interests, abilities and motivation of participants, special pedagogical methods and techniques of educational work are selected
Adaptive learning	Personalized learning, in which real-time computer technology adapts the learning material in accordance with the needs of students
Self-education	Complete freedom and responsibility of the student in the choice of educational tasks, content, and didactic means to achieve the educational goal. The role of an educational institution in this case is a service one. For example, providing infrastructure for social and collaborative interaction.
Expanding the student's capabilities	It is especially in demand in large introductory courses, in the process of career guidance and selection of a set of disciplines for in-depth study.

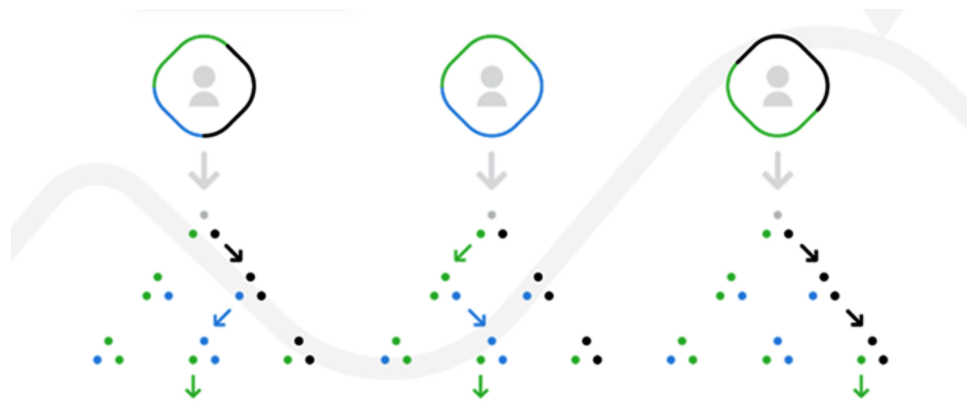


FIGURE 1 – Personalized learning model

Thus, personalized learning can be described as a type of learning, the organization of which takes into account the individual characteristics and needs of the student and gives the opportunity to independently (or with the support of a teacher) determine the learning trajectory. At the same time, the main criterion is a systematic constructive feedback throughout the learning.

As practice and the results of the study show, personalized learning is a rather time-consuming process for a teacher, given that on average 22-28 students study in the classroom. Manually developing individual development trajectories and accompanying each student will take up all the teacher's working time. It is safe to say that the organization of an effective personalized learning process that meets the needs and abilities of the student and the needs of the modern society in which he lives can be achieved only with the use of information technology. Their main task is to optimize the learning process in accordance with the needs of the student and systematize the teacher's activities in this direction [20–23]. These technologies also make it possible to ensure the development of self-regulation and metacognition of students by building flexible educational routes.

Having analyzed the results of a questionnaire survey of interested parties (teachers, high school students, parents of Nazarbayev Intellectual School in Ust-Kamenogorsk) within the framework of designing a personalized learning system based on a logical-structural method, the authors identified a list of factors contributing to the introduction of PL into the educational process of schools:

- creation of an electronic educational platform;
- improvement of the regulatory framework;
- technical and resource support of the learning process;
- development of a system of professional development and motivation of teachers.

Based on these factors and the results of the analysis stage of the logical-structural method, a conceptual model for the implementation of personalized learning with the support of information technology was built (Fig. 2).

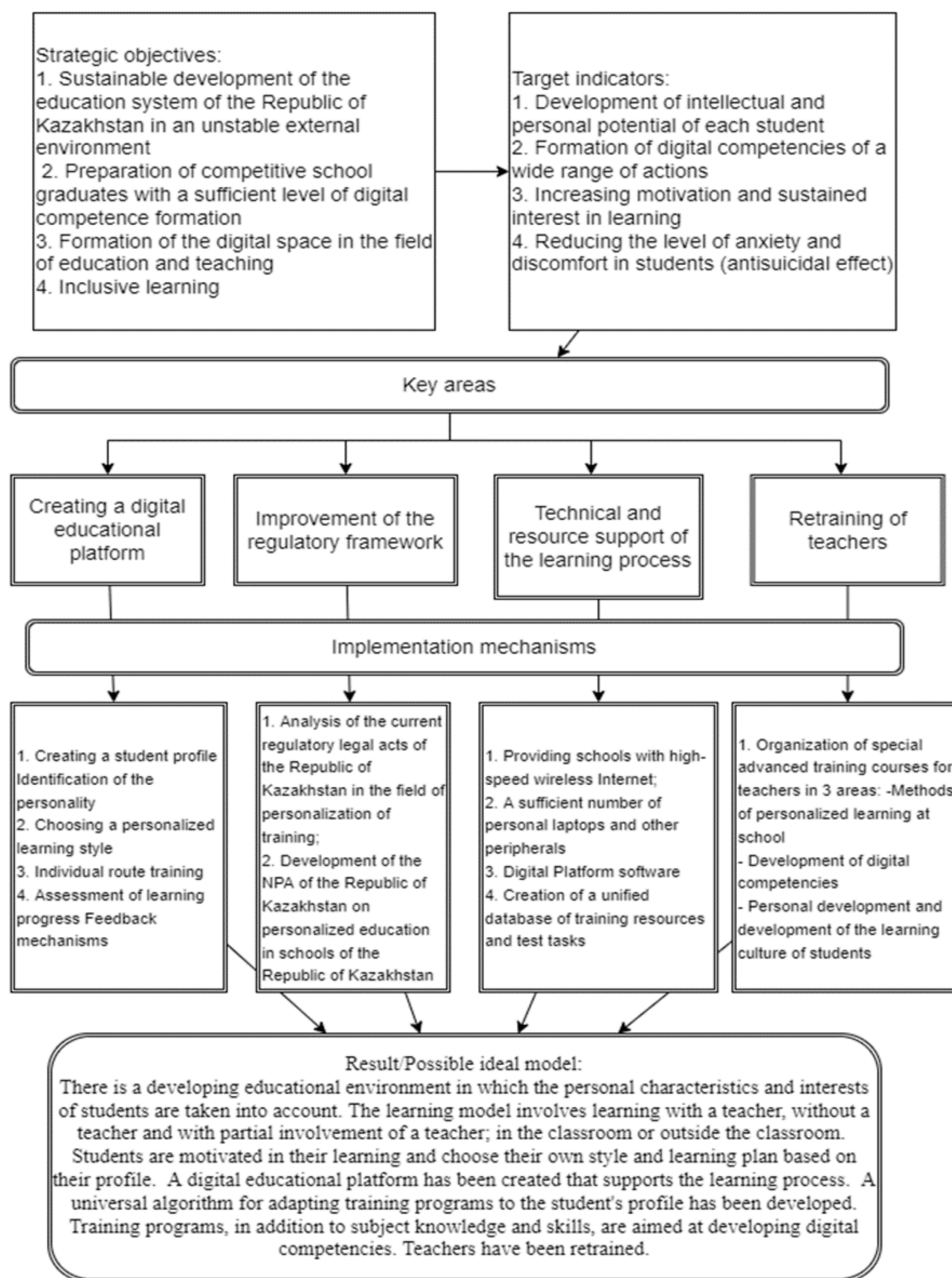


FIGURE 2 – Conceptual model of software implementation with information technology support

This conceptual model presents 4 key areas: creation of a digital educational environment, improvement of the regulatory framework, technical and resource support of the learning process, retraining of teachers and suggests possible mechanisms for their implementation. Within the framework of this study, the first direction will be considered, which is directly related to the use of information technology.

4. RESEARCH RESULTS  
 ARCHITECTURE OF A PERSONAL EDUCATIONAL PLATFORM

For the possibility of practical implementation of personalized education for high school students of Nazarbayev Intellectual Schools, a software complex "Personal Educational Platform" (hereinafter referred to as PEP) was developed. This software complex includes the learning of students in courses with in-depth or extended content in the subjects of the natural and mathematical cycle, which in turn, in addition to subject skills and knowledge, develop a number of digital competencies.

The development of digital competencies will be carried out through integration into the content of a competency-oriented educational program of a certain course. The set of digital competencies was determined based on the hierarchy analysis method and presented as an independent study in a separate article [24]. In the process of learning, the digital footprint of students accumulates in the PEP, which accumulates in their profiles. The analysis of the accumulated data in the profiles makes it possible to increase the effectiveness of training by determining the individual orientation for each individual student.

Let's take a closer look at the software architecture of PEP. The conceptual scheme of the PEP software architecture is shown in Figure 3.

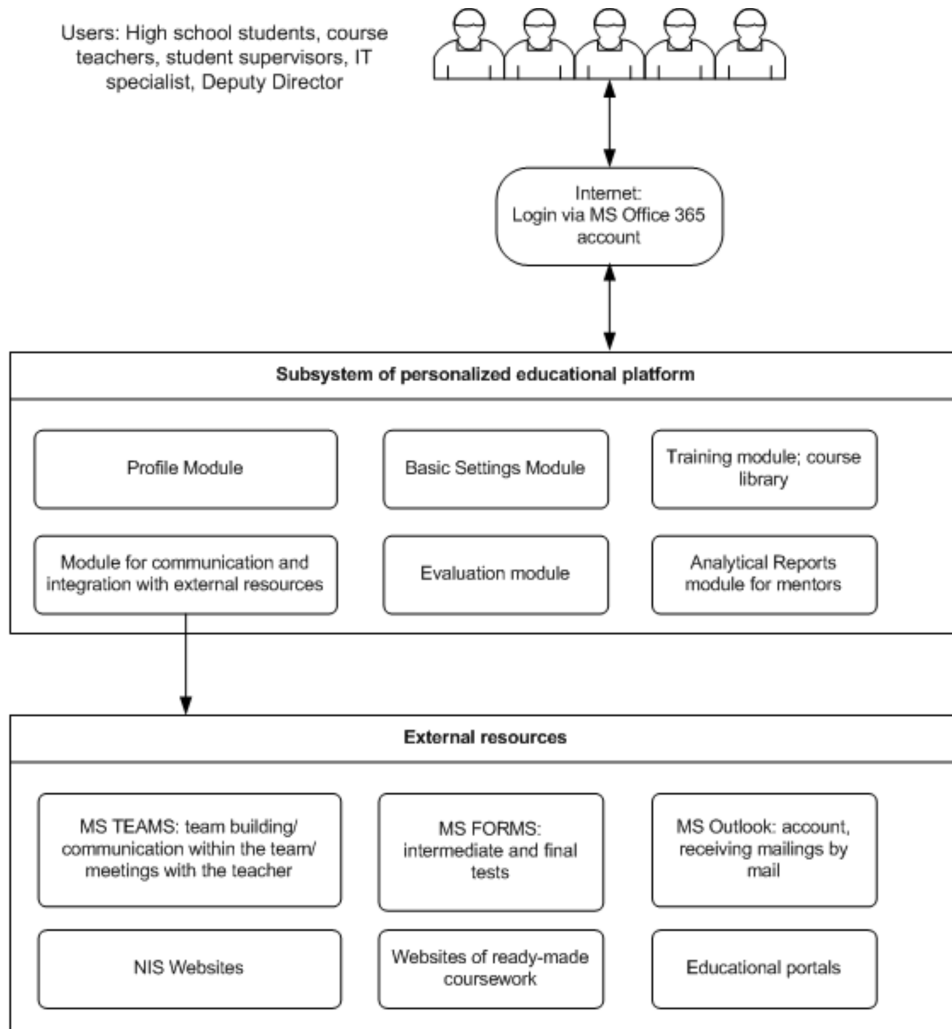


FIGURE 3 – Conceptual architecture of a personal educational platform

As we can see in Figure 3, the PEP system includes 6 basic modules

1. Profile module – this module provides functionality for working with user profiles (creation, data collection, etc.)

2. Basic settings module – this module provides functionality related to configuring the operation of the entire system as a whole
3. Educational model – this module provides the functionality of courses in the subjects of study
4. Assessment module - this module provides mechanisms for assessing the level of preparation of students for learning
5. Integration module - this module provides tools for interacting with external systems
6. Analytical reports module – this module provides tools for the analysis of training

Next, consider the software architecture of the PEP (Fig. 4)

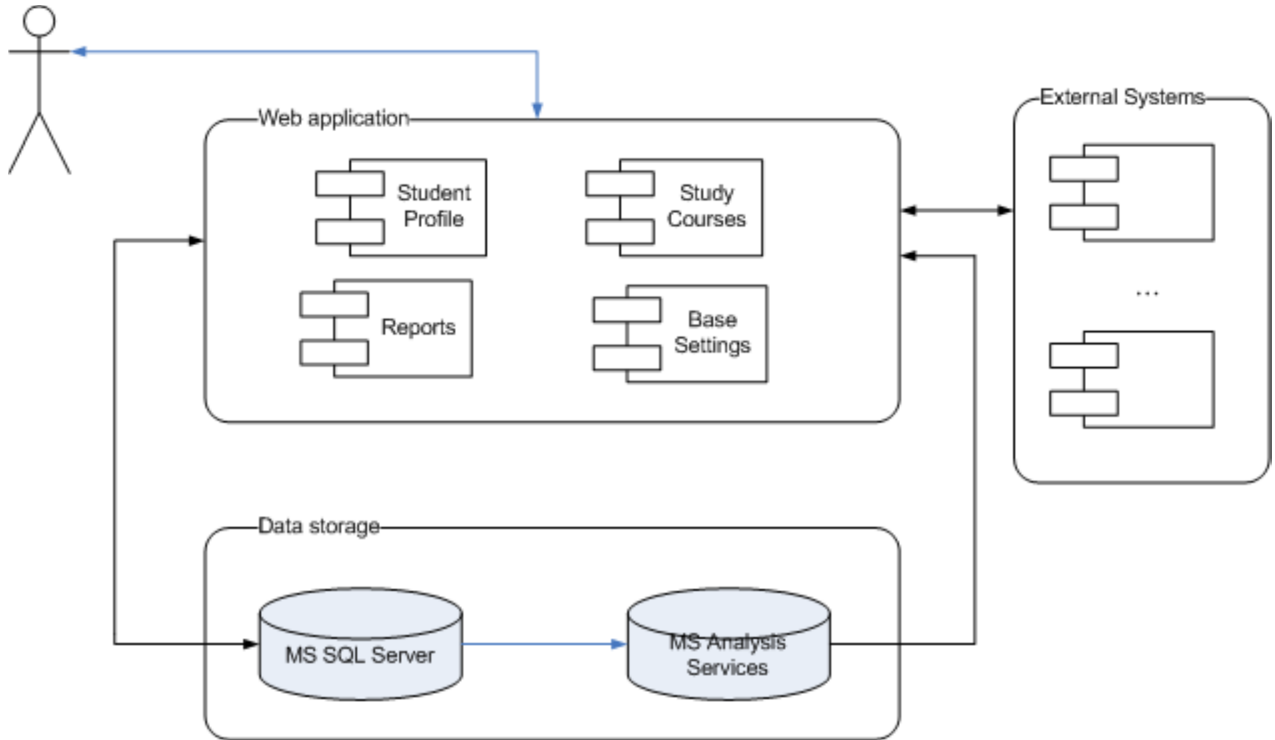


FIGURE 4 – Software architecture of PEP

As can be seen from the diagram in Figure 4, the software components of the architecture are divided into 3 levels:

1. Data storage. At this level there are software components that are designed to support the functioning of the system database and conduct analytical calculations. The components of this level include:
  - (a) A database management system based on Microsoft SQL Server 2017. This DBMS contains the main PEP databases.
  - (b) A data analysis system based on Microsoft SQL Analysis Services. This component is used to analyze data that is accumulated in the main database using algorithms such as decision tree, neural network, naive Base classifier.
2. Web application. This component is a web application that the end users of the system (students, teachers and other interested parties) work with. This application is implemented on the basis of Microsoft ASP technology.Net 4.7 and operates on the basis of the Microsoft Internet Information Services 10 web server. This application interacts with the system's data storage and interacts with external components. The main components of this web application are those that correspond to the conceptual components of the system that were listed earlier:
  - (a) Student Profile
  - (b) Training courses
  - (c) Basic settings

- (d) Report
- External systems. This part includes external to the PEP system, which is required for learning and support services that are not part of the system. The list of external systems is shown in Figure 3.

5. THE ALGORITHM OF THE PERSONAL EDUCATIONAL PLATFORM

Registration of students is carried out through corporate mail. After registration, the main page opens, where you need to go to the student's profile. The input database will be preloaded by the administrator.

A more detailed algorithm for the operation of the personal educational platform is given in Fig. 5.

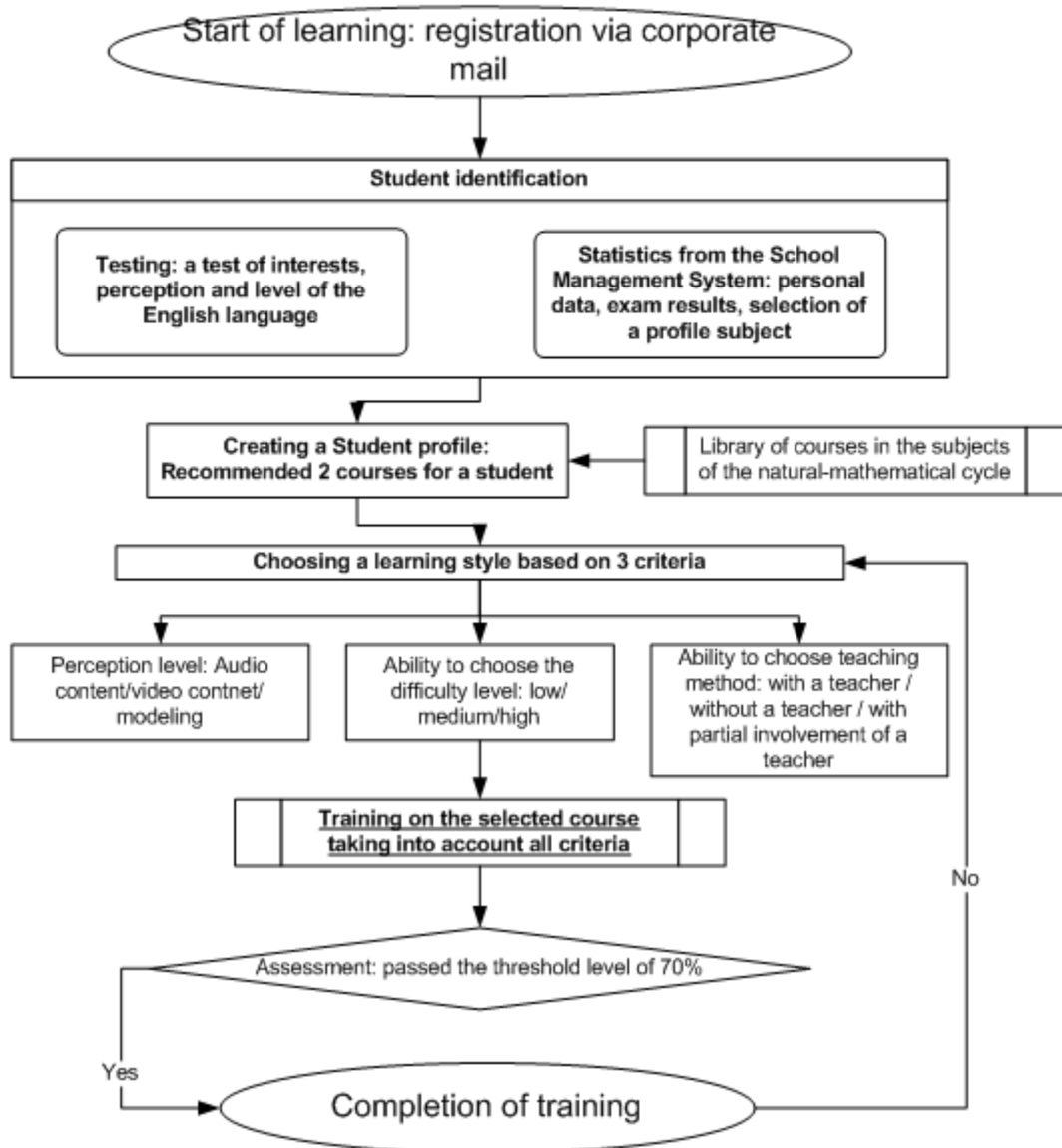


FIGURE 5 – The algorithm of the personal educational platform

The student's profile is determined by the following criteria:

Testing:

- Results of the material perception test
- Results of the interest determination test
- The level of language competence in English (test to determine the level: pre - intermediate, intermediate, upper intermediate)

#### Statistics:

1. Personal data of the student
2. Results of the external exam for the 10th grade in the subjects: chemistry, physics, mathematics, computer science, biology
3. Selection of specialized subjects (carried out by the student himself)

Also, if the profile is incomplete, it is possible to pass the necessary automated tests. Only after activating the profile, the "recommended courses" window opens for the student, the system recommends no more than 2 courses for one academic year, and also gives recommendations for effective study according to the following criteria:

1. Perception level: audio content/ video content/modeling (menu option)
2. The ability to select the difficulty level: low /medium / high (the option to select in the menu)
3. The possibility of choosing a teaching method: with a teacher / without a teacher / with partial involvement of a teacher (the possibility of choosing in the menu)

## 6. CONCLUSION

The experience of the education system during the coronavirus pandemic, knowledge and experience in the use of new information technologies allow us to implement a new model of personalized learning, which will be able to provide high quality knowledge in conjunction with the development of students' personality.

The concept of transformation of a new model of education in an unstable external environment is based on the creation of a personal educational platform for students, taking into account their initial levels of knowledge and personal characteristics.

The article describes the project of a personal educational platform to support personalized learning of high school students. A conceptual model of PL implementation in the school system is proposed and the architecture, models and algorithms of the personal platform are developed. The approbation is planned to be carried out on a cycle of elective courses in the subjects of the natural science cycle on the basis of the Nazarbayev Intellectual School of Ust-Kamenogorsk. Based on the results of testing the platform and testing the content of courses aimed at the development of digital competencies, recommendations will be prepared on the use of research results in the network of Nazarbayev Intellectual schools and specialized schools for gifted students of Kazakhstan Republic.

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**Жоғары сынып оқушыларына арналған дербестендірілген оқытуды қамтамасыз ететін жеке білім беру платформасының жобасы**

**Аннотация:** Қазақстанда дербестендірілген оқытуға көшудің жобалау жүйесін әзірлеу сыртқы ортаның тұрақсыздығын ескере отырып, ақпараттық технологиялар саласында да, мектептегі білім беру саласында да инновацияларды дамытудың маңызды бағыты болып табылады. Бұл мақалада Қазақстан Республикасы мектептерінде білім берудің осы түрін жүзеге асырудың авторлық тұжырымдамалық моделіне негізделген жоғары сынып оқушыларының дербестендірілген оқытуын қолдауға арналған жеке білім беру платформасының жобасы ұсынылған. Зерттеу жұмысының нәтижесінде жеке білім беру платформасының архитектурасы әзірленді, ішкі жүйелер мен микросервистерге сипаттама берілді, платформаның жұмыс істеу алгоритмі ұсынылды.

**Түйін сөздер:** жобалау жүйесі, ақпараттық технологиялар, дербестендірілген оқыту, концептуалды үлгі, жеке білім беру платформасы, архитектура

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**Проект персональной образовательной платформы поддержки персонализированного обучения учащихся старшей школы**

**Аннотация:** Разработка системы проектирования перехода на персонализированное обучение в Казахстане является важным направлением развития инноваций как в сфере информационных технологии, так и в сфере школьного образования с учетом нестабильности внешней среды (ситуация с пандемией Covid-19). В данной статье представлен проект персональной образовательной платформы поддержки персонализированного обучения учащихся старшей школы, основанный на авторской концептуальной модели внедрения данного вида обучения в школы Республики Казахстан. Разработана архитектура персональной образовательной платформы, описаны подсистемы и микросервисы, предложен алгоритм работы платформы.

**Ключевые слова:** система проектирования, информационные технологии, персонализированное обучение, концептуальная модель, персональная образовательная платформа, архитектура

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