

# THE STUDY OF THE TRANSITION TO PERSONALIZED LEARNING OF SCHOOLCHILDREN IN THE REPUBLIC OF KAZAKHSTAN BASED ON A LOGICAL-STRUCTURAL APPROACH

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## ABSTRACT

This article discusses the issue of transition to personalized learning in schools of the Republic of Kazakhstan. The expert study was conducted on the basis of the results of a survey of the main participants of the study - students, parents and teachers of the network of Nazarbayev Intellectual schools. The results obtained allowed us to identify three strategic directions that ensure the transition to a personalized format within the framework of a research project.

**Keywords:** *Personalized Learning, Electronic Educational Environment, Expert Assessment, Logical-Structural Approach, Ranking Method*

## 1. INTRODUCTION

The development of the innovative economy as a priority direction of Kazakhstan's industrial policy involves active training of young specialists with a high level of competence in various problem areas and in the field of information technologies, taking into account current trends in digitalization of innovative development [1-3]. And here the restructuring of the school education system requires special attention, since the school lays the foundation for innovative development and digital transformation of the national economy.

On the other hand, the sphere of information technology can be characterized as a rapidly changing environment, which also determines the active development of modern educational technologies. One of such technologies is personalized learning (PL). The technology is implemented on the basis of the functioning of the electronic information and educational environment, which includes electronic information

resources, electronic educational resources, a set of information and telecommunication technologies.

According to the results of the study "Informed progress. Understanding the implementation of personalized learning and its effects" students demonstrate the best results in those schools where the emphasis is on a personalized approach. The Center for Digital Education of the USA conducted a survey of the country's national schools in 2018. 90% of respondents answered that they implement computer technologies and attract specialists in order to provide a personalized approach to learning [4]. FORBES magazine also named personalized learning as one of the main trends in education in 2019 [5]. Experts noted the high social role of the approach.

Kazakhstan at this stage of the development of the education system is working in accordance with the State Program for the Development of Science and Education for 2020-2025. According to this document, in 2017 Kazakhstan became a member of two relevant

OECD committees - the Committee on Educational Policy and the Committee on Scientific and Technological Policy, which testifies to the international recognition of the achievements of the Kazakh education system. Nevertheless, the current education system has a number of short-comings. The assessment of the level of literacy and competencies of the population of Kazakhstan indicates a significant lag from many countries of the world. Based on the results of the Program of International Assessment of Adult Competencies (16-65 years old) OECD -Organization for Economic Cooperation and Development, Kazakhstan ranked 34th in reading, 33rd in mathematical literacy (out of 39 countries) and 32nd in literacy in the field of information and communication technologies (out of 36) [6]. Kazakhstan's results are much lower than the average of the OECD member countries and the Russian Federation. These studies show that urgent measures are needed to further develop the school education system within the framework of a competence-based approach taking into account new trends in the field of information technology. The network of Nazarbayev Intellectual Schools could act as a driver of such development [7]. The network of Nazarbayev Intellectual Schools of the Republic of Kazakhstan operates on an innovative educational model that allows school graduates to successfully compete in the global educational space and enroll in the world's leading universities. At this stage, all schools are internationally accredited by the Council of International Schools, the Netherlands, which confirms the quality of the services provided. The successful experience of Nazarbayev Intellectual Schools is gradually being introduced into secondary schools in Kazakhstan [8].

From the standpoint of today, according to the Strategy for the development of the NIS network, an urgent task is the transition to personalized learning, which presupposes the widespread use of modern information and communication technologies. To solve this problem, it is advisable to use a project approach with a clear formulation of the goals and objectives of the project, indicators of achievement of the goal, possible risks, etc. Therefore, when developing this project, it is proposed to use logical and structural analysis as a methodological basis, assuming the subsequent implementation of the analysis stage and the planning stage. The analysis stage provides for the analysis of project stakeholders, on the basis of which a tree of problems, a tree

of goals is built and strategies for achieving goals are determined. At the planning stage, a logical and structural matrix of the project is built, on the basis of which calendar and resource plans for the implementation of the project are formed [9-10].

Since the planning stage is more formal in comparison with the analysis stage, as well as due to the limited scope of the article, in the current work, the authors considered it appropriate to focus on the analysis stage as a meaningful stage of work that defines the boundaries and content of the project. In the proposed work, using the example of the NIS network, the results of the study of the problems of transition to personalized learning technologies are presented based on the analysis of the results of the survey of the main stakeholders - students, parents and teachers of the Nazarbayev Intellectual Schools network.

The purpose of the described research is to identify strategic directions that ensure the transition to personalized learning (using the example of the Nazarbayev Intellectual Schools network).

Research plan:

- 1) determining the composition of respondents from among high school students, teachers and parents;
- 2) development of a questionnaire for the subsequent survey of respondents;
- 3) conducting a questionnaire survey;
- 4) processing of survey results by ranking method;
- 5) identification of the main factors hindering the implementation of PL;
- 6) formation of a "problem tree";
- 7) development of a "goal tree" and definition of a strategy for achieving goals.

## 2 LITERATURE REVIEW

The analysis of domestic and foreign literature on this topic allowed us to determine that personalized learning is considered as a significant aspect of the development of higher education. This type of training leads to the formation of an important value of "Lifelong Learning". The founders of the study of this problem are such scientists as E. Munier, A.V. Petrovsky, V.A. Petrovsky. In works [11-12], personalization of an individual is considered as a process which considers how a subject can act in public life as a

person. In this regard, personalization is manifested in the system of people's mutual relations [13-15].

Initially, the idea of personalization appeared in the writings of Jean-Jacques Rousseau in 1762 and meant creating an environment in which the student would like to study himself. In 1968, Benjamin Bloom, in his article "Learning for Mastery", identified four main conditions for the implementation of PL: a good tutor, a convenient pace of learning, a guide, an individual trajectory of development [16]. In 2005, Dan Buckley identified two areas of personalization of learning in his research: personalization of the program, when the learning adapts to a specific listener, and personalization by the learner himself, when the listener independently builds his learning [17]. In the literature, you can also find another variant of the types of personalization: when content adapts and when motivation and engagement tools adapt. In the first option, students using the previously selected evaluation system are evaluated, and then content in different forms for each group of employees is created. In the second case, the content remains, but the tools of engagement are replaced [18]. The choice of one or another type of personalization depends on the goals of learning, the category of students and the capabilities of the organization, including technical ones.

A review of the literature has shown that the concept of PL is often confused with the terms "differentiated learning" and "individual learning". True PL provides a training program and an approach adapted to the abilities, interests, preferences and other needs of each student. The document "The Transformation of American Education: Technology-based Learning" notes that the PL includes, but goes beyond, both individualized learning and differentiated learning:

"Personalization means learning that adapts to learning needs (which means individualization), taking into account learning preferences (which means differentiation) and taking into account the specific interests of students" [19].

To sum up, personalized learning can be characterized as an educational model in which programs, teaching methods and academic strategies are focused on the individual needs, interests and socio-cultural background of the student. In this case, the trajectory is built in the

learning process, depending on the student's results in intermediate tests. The rules about when to conduct testing and what to advise to study further with different results are set in advance by the teacher. It turns out something similar to a decision tree, along which students will go differently depending on their success, but the tree itself must be thought out and created by the teacher. This interpretation of the concept of "personalized learning" is taken as the basis of this study.

PL implementation is inextricably linked with information technology. In the context of informatization of education, the concept of "information and communication educational environment" (ICEE) is widely used as "a set of objects of the educational process (content, forms, methods, means of teaching and educational communications) based on information technologies, with variable characteristics providing the subjects of the educational process (learner, teacher) with the possibility of constructing educational and cognitive activity" [20].

This functional capability of ICEE allows us to talk about a personal learning environment based on information and communication technologies, which is obtained from ICEE by adapting its structural components in accordance with the goals, planned results, content of training, needs and abilities of trainees [21-23]. The importance of using information technologies to support the personalization of learning is well disclosed in the study "Reimagining the Role of Technology in Education" (2017) [24]. In higher educational institutions, various projects are being researched and implemented aimed at developing the personalization of learning using various platform solutions, where students can determine their level of knowledge and choose their own learning trajectory using artificial intelligence [25-27].

As examples, published works can be cited here, where various solutions are proposed regarding personalization technologies in e-learning systems. These include the work [28] devoted to an agent-based approach to developing a system of recommendations for improving learning skills and simplifying the choice of courses in accordance with the interests and preferences of users. The paper [29] presents a set of frameworks in which different types of e-learning systems using different learning philosophies and student learning preferences support the learning curve of the

student. The authors of the work [30] propose an adaptive recommendation model of e-learning, which allows to build an educational trajectory taking into account the level of knowledge and learning style as a personal way of moving the learner through the cycle of cognition. It is not difficult to notice that these studies aimed at using the technological advantages of e-learning and improving its quality have become acutely in demand in the context of the pandemic limitations of COVID 19. This is true for most countries of the world. In particular, in the Republic of Kazakhstan, serious attention is paid at the state level to the tasks of informatization of education and the transition to new advanced learning technologies [31-32].

Theoretically, the creation of a personal educational environment based on the use of modern information technologies is the main goal of the proposed project of transition to personalized education in schools of the Republic of Kazakhstan, and its development requires a detailed analysis of existing problems.

### 3. METHODOLOGY

The methodological basis of the conducted research is the logical-structural approach (LSA), which is actively used in the development and implementation of various projects, including projects in the field of informatization.

The logical-structural approach consists of a stage of analyzing problems and developing goals that need to be achieved to solve these problems, as well as a planning stage that defines specific actions aimed at achieving goals. This approach provides two stages of work, detailed below.

The analysis stage includes:

1) problem analysis - identification of stakeholders, their key problems, obstacles and opportunities; identification of cause-and-effect relationships between problems;

2) goal analysis - development of goals arising from the identified problems; determination of the "means-end" relationship;

3) strategy analysis - defining a strategy for achieving goals and setting the main goals (general goals and project goals)

The planning stage provides:

1) building a logical matrix of the project - defining the structure of the project, checking its internal logic, as well as formulating goals in

measurable quantities, determining funds and costs (in general);

2) activity planning - determination of the sequence and interdependence of actions, assessment of their duration, setting of tasks and distribution of responsibility;

3) resource planning - based on the action plan, a resource expenditure plan and a project budget are developed.

As noted earlier, the authors considered it appropriate to focus on identifying and analyzing the problems of transition to personalized learning technologies. An important incentive for such a decision is that this stage of work determines all the further steps required to implement the process of such a transition. The choice of the Nazarbayev Intellectual Schools network as an object of research is dictated by the following circumstances:

- ✓ The NIS network is an outpost for the introduction of innovative methods of teaching schoolchildren in Kazakhstan by the example of working with talented youth;
- ✓ the level of technical equipment of the network participants is much higher than the level of equipment of ordinary schools;
- ✓ students of intellectual schools have a serious motivation to acquire a high level of competence and use modern information and communication technologies;
- ✓ NIS educational institutions have experience in implementing large joint innovative projects;
- ✓ the positive experience of the NIS network is being broadcast to secondary schools in Kazakhstan.

### 4. ANALYSIS STAGE

#### 4.1 Problem Analysis

The first point of the analytical phase is to identify the stakeholders of the project and identify the level of their interest. Interested sides are individuals, groups of individuals or institutions whose interests are affected by the project. In our case, the transition to personalized learning is interesting primarily for high school students and their parents, teachers teaching in high school. Also, during the implementation of the project, the interests of the leading structures in the field of education are affected: the Ministry of Education of the Republic of Kazakhstan, the Republican Center DARYN, AOE "NIS". Here we immediately note that, following the ideology of the logical-structural approach, the influence of these organizations on

the project is supposed to be taken into account as assumptions (risks), and therefore will not be further analyzed in detail.

In the 2020-2021 academic year, the authors initiated the conduct of questionnaire surveys aimed at identifying the problems of transition to personalized learning in intellectual schools. The survey covered the network of intellectual schools of Kazakhstan in all regions and was intended primarily for the main stakeholders of the project: students and their parents, teachers.

Since there are no questions in the statistical observation program, the answers to which are measured in interval and relative scales, the calculation of the minimum sample size was carried out according to the well-known formula:

$$n = \frac{t^2 w(1-w)N}{N\Delta^2 + t^2 w(1-w)}, \quad \sigma^2 = w(1-w) = 0,25 \quad (1)$$

where  $\sigma^2$  – variance (assumed to be 0.25);

$t$  – the confidence coefficient (for a confidence probability of 0.954 is 2);

$\Delta$  – marginal sampling error (0.11);

$N$  – the number of the general population (19 schools – a total of 4797 students and, accordingly, 4797 parents, 402 high school teachers [33].

The minimum sample size ensuring its representativeness: 83 in the survey of students and parents, 67 in the survey of teachers.

At the first stage, a survey was conducted among high school students and their parents (grades 10-12), 101 responses were received from parents

(<https://forms.office.com/Pages/DesignPage.aspx?fragment=FormId%3DyVLbOR7jwkKAg3U1W3KN45vKqSoT3OxLqgGTjt2ywcpUOEUXWEtIRFg2QjU1OFrOR1M3RzI3UEtWUC4u%26Token%3Da6e00510a30c40d1afd6770767105df8>) and 123 from students (<https://forms.office.com/Pages/DesignPage.aspx?fragment=FormId%3DyVLbOR7jwkKAg3U1W3KN45vKqSoT3OxLqgGTjt2ywcpUODdIRVZHVfDdODJPN1IKS0JCSFZTR08yRy4u%26Token%3D884b316d1b0448b1b465aa8c4784a517>).

At the second stage, the survey covered the teaching staff of intellectual schools of Kazakhstan in the number of 102 people (<https://forms.office.com/Pages/DesignPage.aspx?fragment=FormId%3DyVLbOR7jwkKAg3U1W3KN45vKqSoT3OxLqgGTjt2ywcpUOEUXWEtIRFg2QjU1OFrOR1M3RzI3UEtWUC4u%26Token%3Da6e00510a30c40d1afd6770767105df8>).

[45vKqSoT3OxLqgGTjt2ywcpUQzBUQVhaVkpWTFcyQjFSQTLQkNOUEpFRi4u%26Token%3Dc18021aa7c364eb3ad02057c3f298082h](https://forms.office.com/Pages/DesignPage.aspx?fragment=FormId%3DyVLbOR7jwkKAg3U1W3KN45vKqSoT3OxLqgGTjt2ywcpUQzBUQVhaVkpWTFcyQjFSQTLQkNOUEpFRi4u%26Token%3Dc18021aa7c364eb3ad02057c3f298082h)).

These links are available to users with an Office 365 work or study account, as they were developed and conducted in accordance with internal corporate acts of the NIS Autonomous Educational Organization of the Republic of Kazakhstan.

The initial analysis of the survey data allowed us to identify the main 6 factors preventing the introduction of personalized learning on which students and parents focus their attention: the lack of a personal educational environment (educational platform), lack of structuring of the proposed resources, subjectivity of assessment, poor consideration of individual needs and interests, lack of a re-source base, weak motivation of teachers (including material).

For further processing of the survey data, the ranking method was used [34]. Number of factors  $n=6$  Number of expert categories  $m=4$  Based on the questionnaire data, a summary matrix of ranks was compiled (Table1).

Table 1: Summary matrix of ranks

Factors hindering the implementation of PL		Experts			
		1 scho ol stud ent	2 paren t	3 teac her	4 admi ni strati on
$x_1$	Unstructured nature of the resources offered	3	4	5	4
$x_2$	Subjectivity of evaluation	5	6	3	4
$x_3$	Weak consideration of individual needs and interests	4	3	1	3
$x_4$	Lack of a personal learning environment (educational platform)	1	1	3	1
$x_5$	Weak motivation of teachers (including material ones)	6	5	6	6
$x_6$	Lack of a resource base	2	2	2	2



Due to the fact that in this matrix there are identical rank numbers in the assessment of experts 3 and 4, the ranks were reformed without changing the opinion of experts (Table 2).

Table 2: Reformation of Expert ranks №3 and №4

Seat numbers in an ordered row	1	2	3	4	5	6
Location of the factors of Expert №3	1(x <sub>3</sub> )	2(x <sub>6</sub> )	3(x <sub>2</sub> )	3(x <sub>4</sub> )	5(x <sub>1</sub> )	6(x <sub>5</sub> )
New ranks of Expert №3	1	2	3,5	3,5	5	6
Location of Expert Factors №4	1(x <sub>4</sub> )	2(x <sub>6</sub> )	3(x <sub>3</sub> )	4(x <sub>1</sub> )	4(x <sub>2</sub> )	6(x <sub>5</sub> )
New ranks of Expert №4	1	2	3	4,5	4,5	6

Based on the reformation of ranks, a new rank matrix was constructed (Table 3).

Table 3: Rank matrix

Factors hindering the implementation of PL	Expert categories				Sum of ranks	Δ	Δ <sup>2</sup>
	1	2	3	4			
x <sub>1</sub>	3	4	5	4,5	16,5	2,5	6,25
x <sub>2</sub>	5	6	3,5	4,5	19	5	25
x <sub>3</sub>	4	3	1	3	11	-3	9
x <sub>4</sub>	1	1	3,5	1	6,5	-7,5	56,25
x <sub>5</sub>	6	5	6	6	23	9	81
x <sub>6</sub>	2	2	2	2	8	-6	36
Σ	2	2	21	21	84	S = 213,5	

Checking the correctness of the matrix based on the calculation of the checksum:

$$\sum_{j=1}^n x_{ij} - \frac{(1+n) \cdot n}{2} - \frac{(1+6) \cdot 6}{2} = 21 \quad (2)$$

The sum of the columns of the matrix are equal to each other and the checksum, so the matrix is composed correctly.

Estimates of the studied factors by significance were distributed as follows (Table 4).

Table 4: Location of factors by importance

Factors hindering the implementation of PL		Sum of ranks
x <sub>4</sub>	Lack of a personal learning environment (educational platform)	6,5
x <sub>6</sub>	Lack of a resource base	8
x <sub>3</sub>	Weak consideration of individual needs and interests	11
x <sub>1</sub>	Unstructured nature of the resources offered	16,5
x <sub>2</sub>	Subjectivity of evaluation	19
x <sub>5</sub>	Weak motivation of teachers (including material ones)	23

For clarity, the results obtained can be presented in the form of a diagram (Figure 1), and classify the identified factors by the sum of the ranks.

Based on the diagram, the following conclusions can be drawn:

- ✓ The first group of importance includes two factors: factor x<sub>4</sub> (Lack of a personal educational environment (educational platform) and factor x<sub>6</sub> (Lack of a resource base).

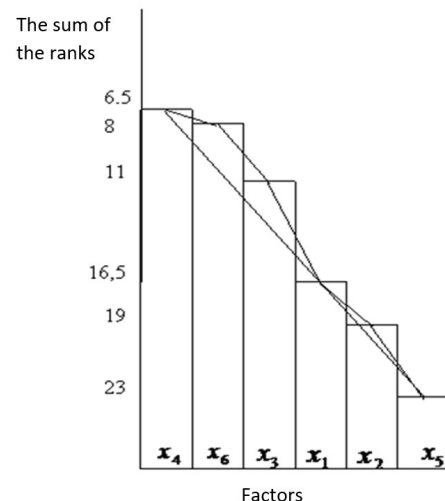


Figure 1: Rank distribution diagram

- ✓ The second group in importance includes one factor x3 (Weak consideration of individual needs and interests).
- ✓ The third group includes factors x1 (Unstructured nature of the resources offered), x2 (Subjectivity of assessment), x5 (Weak motivation of teachers (including material)). So, the following factors are significant factors hindering the implementation of personalized learning: x4, x6, x3.

The authors assessed the average degree of consistency of the opinions of all experts, according to the coefficient of concordance. Calculations according to the formula show:

$$W = \frac{213,5}{\frac{1}{12} \cdot 4^2 \cdot (6^3 - 6) - 4 \cdot 1,0} = \frac{213,5}{276,0} = 0,774 \quad (3)$$

$W = 0.774$  indicates the presence of a high degree of consistency of expert opinions.

$W = 0.744$  - the value is not random, and therefore the results obtained by assessing the factors that hinder the introduction of this type of learning according to their degree of importance have a place to be real and can be used in future research.

Thus, the results of the study based on expert assessments show that significant factors hindering the introduction of a new format of learning are: the lack of a personal learning environment (a single educational platform), the lack of the necessary resource base, poor consideration of individual needs and interests of students in the learning process.

To visually present the results of the expert assessment, a problem tree was constructed, which allows to visualize the identified key problems and their cause-and-effect relationships (Figure 2). As can be seen from Figure 2, the current situation of the introduction of personalized education in schools of the Republic of Kazakhstan can be characterized by the following:

- ✓ The lack of a unified educational platform for use in schools, an algorithm for identifying individual needs, interests and socio-cultural background of the student for the successful assimilation of the material in PL, the ambiguity of the procedure for the formation of

educational materials and test tasks. The reason in this case may be the weak technical and software of schools, the consequence is the limited capabilities of schools (technical and content) for the implementation of PL.

- ✓ Lack of PL resource support in schools. The reasons may be insufficient knowledge of the issues of developing an individual learning program for PL (the absence of a recommended template for an individual learning plan for PL) and the lack of a common electronic database of learning resources focused on the individual needs, interests and socio-cultural background of the student. And as a result - the low level of preparation of the school for the implementation of PL.
- ✓ An important factor is also the staffing of the software process. The lack of qualification and motivation of teachers to support the PL process and the refusal or ignoring of the desires and needs of students result from the problems of the lack of specialized teacher training courses for the implementation of PL and the lack of a comprehensive teacher motivation system. All this leads to limited opportunities for students when choosing a learning format to cover individual needs.

#### 4.2 Goal Analysis and Strategy Selection Stage

The goal tree is an "inverted" problem tree that is transformed into a set of future solutions to problems. Every negative problem turns into a goal if it is rewritten as a positive statement about the future.

"The project strategy is a direction in the project that contributes to the success of the project in its environment" [35]. During the analysis of the strategy, a decision is made about which goals can or will be, and which cannot or will not be achieved within the framework of the project. The starting point for strategy analysis is the goal tree, which is transformed from a problem tree.

The analysis of the strategy for achieving the goals allowed us to identify strategic tasks that ensure the transition to a personalized format: the development of software support PL, the study of the development of individual PL programs, the creation of a common database of e-learning resources, the development of a system for improving the qualification and motivation of teachers (Figure 3).

The choice of one or more strategies is based on criteria that are agreed upon in the project team. In practice, it is often necessary to make a number of compromises in order to balance the different interests of stakeholders or the project team, the context of the project and practical constraints. Nevertheless, the choice of a project strategy can be tactically processed if there is an agreed set of criteria by which the merits of various intervention options can be assessed. In our case, the set of criteria included:

- ✓ expected contribution to the development of education, implemented through the improvement of the current model of distance learning;
- ✓ technical feasibility: a technically feasible strategy;
- ✓ implications for capital and operating costs, as well as the ability to cover current costs at the local level;
- ✓ integration with current and planned state programs and projects: supports updated learning programs of general educational schools of the Republic of Kazakhstan; does not contradict the rules of distance learning.

## 5. CONCLUSION

This study, based on the logical-structural approach and the ranking method, identified a list of significant factors that hinder the introduction of personalized learning in schools of the Republic of Kazakhstan. As part of the study, 326 respondents of the Nazarbayev Intellectual Schools network took a questionnaire survey. A "problem tree" was constructed, describing key problems, obstacles and opportunities and showing cause-and-effect relationships between problems, and a "goal tree" was created to develop goals from identified problems and to determine the means-goal relationships. The analysis and selection of the most effective strategies for solving the problem has been carried out. As a result of the conducted research, three strategic directions were identified that ensure the transition to a personalized learning format:

1. Expanding the capabilities of schools (technical and substantive) PL implementation, which includes such specific actions as the development of software support PL, the development of a clear procedure for the formation of education-al materials and test tasks; the creation of an algorithm for identifying individual needs,

interests and socio-cultural background of the student;

2. Providing high-quality resource and methodological support for the processes, including the creation of a unified electronic database of training re-sources and templates for individual personalized learning programs;

3. Professional development and motivation of teachers through the organization of a cycle of courses on the introduction of a new learning format and the implementation of an effective system of moral and material motivation of teachers.

Thus, the application of a logical-structural approach to the analysis of the problems of the transition to personalized learning technologies allowed:

- ✓ unambiguously identify the circle of stakeholders of the future project and find out their attitude to the project;
- ✓ systematically cover the problems that the project should be dedicated to solving;
- ✓ clearly formulate the project objectives;
- ✓ define strategies to achieve the project goals.

According to the logical-structural approach, the stage of determining strategies involves taking into account possible threats and risks that the project cannot affect. But they are taken into account as assumptions, and the fulfillment of these assumptions is constantly monitored during the execution of the project. This ensures timely response to threats of negative events that hinder the successful implementation of the project, as well as opportunities for full or partial damping of threats.

The results of the conducted research create the basis for the subsequent formation of the logical and structural matrix of the project and the development on its basis of calendar and resource plans for the future project of the transition of intellectual schools of Kazakhstan to personalized learning technologies.

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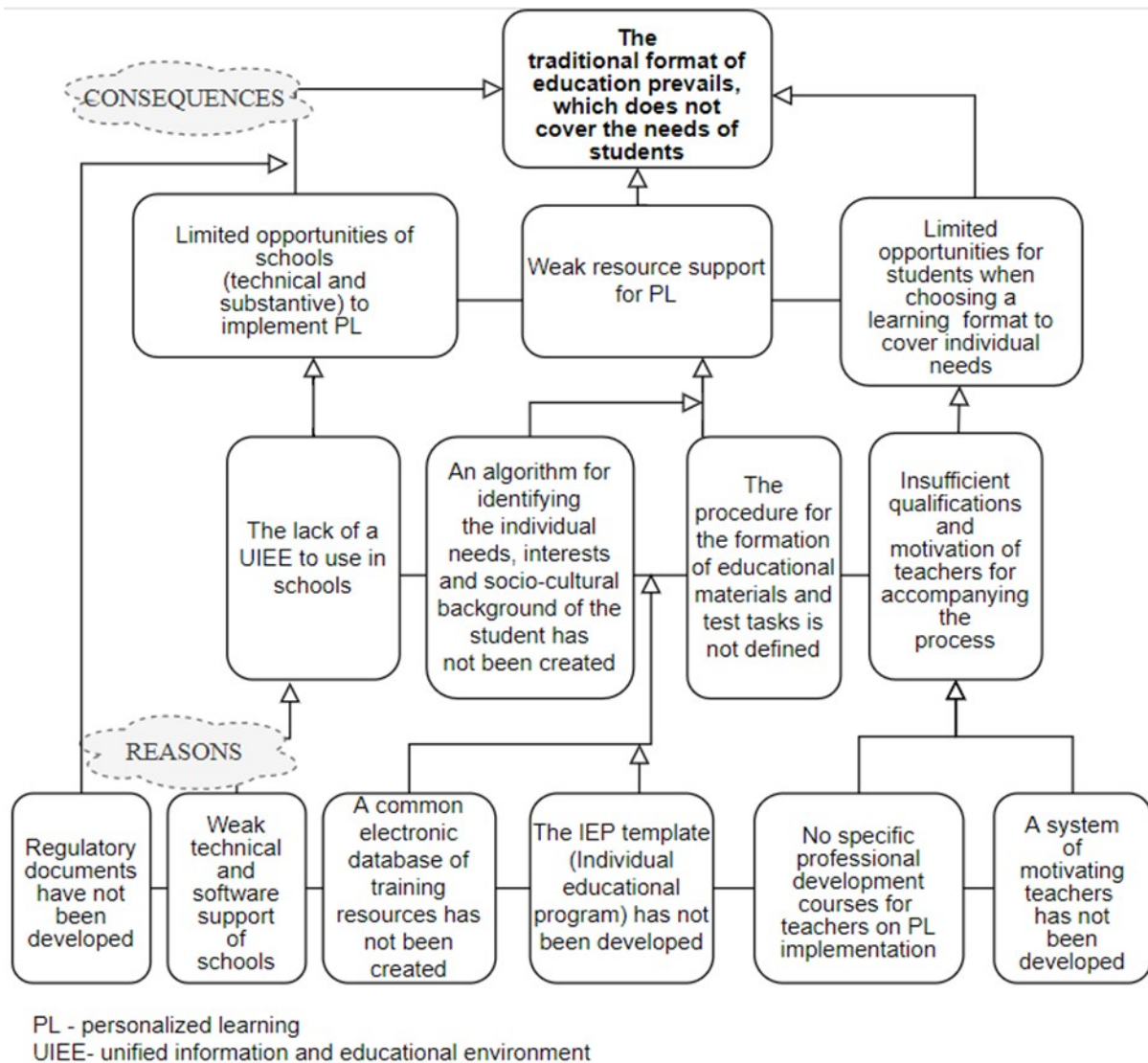


Figure 2: The Tree Of Problems Of Implementing Personalized Learning To Secondary Schools

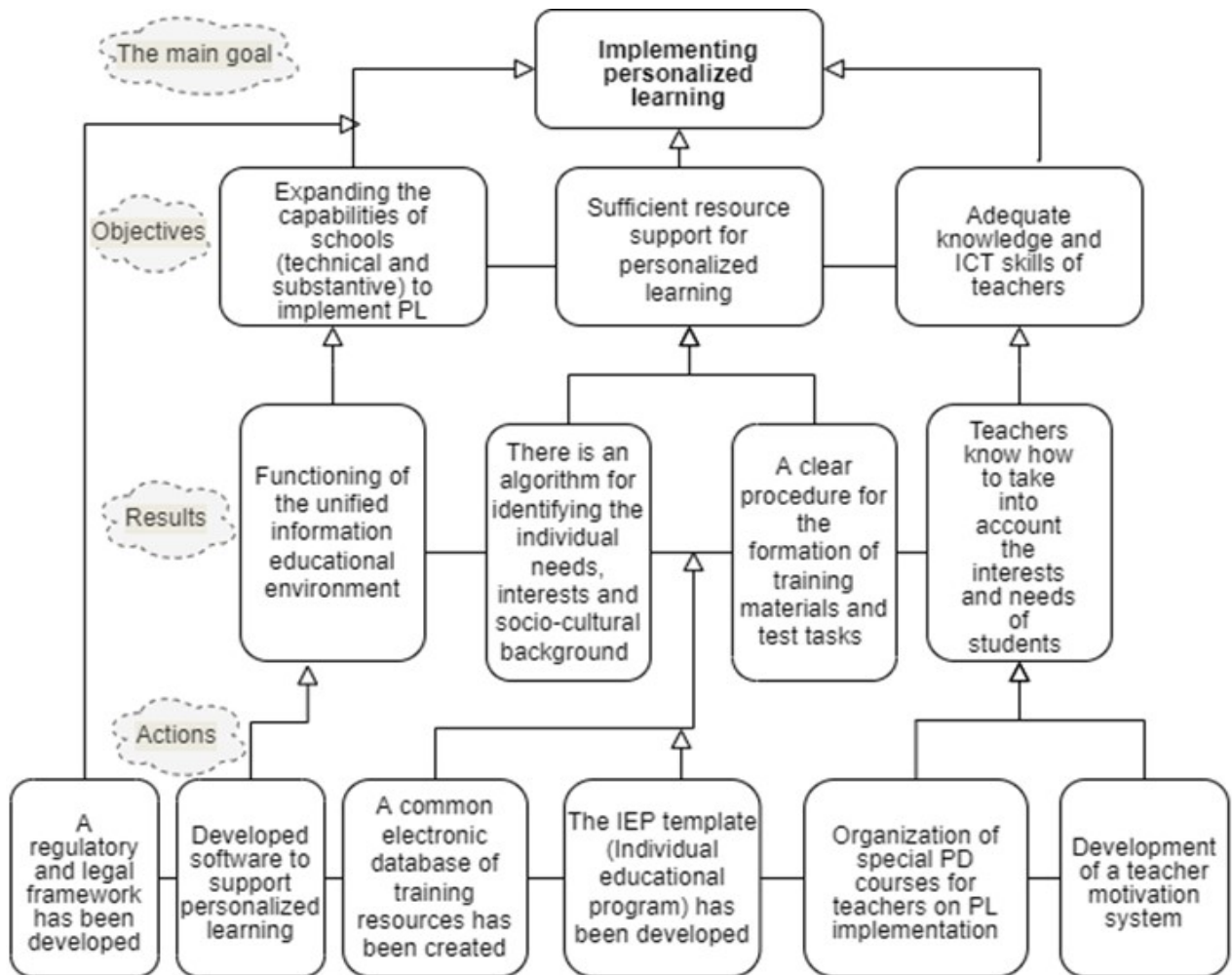


Figure 3: Choosing A Strategy For The Transition To Personalized Education To Secondary Schools