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Development of Information Resources to Ensure Continuing Education and Knowledge Transfer in Chemical Universities

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Modern education requires the integration of content and learning technologies. Distance learning is not only an opportunity to study individually, regardless of the place and time, but it is also the opportunity to learn during the whole life. Development of the resources can provide continuing education and knowledge transfer at various universities, including chemical. All countries over the world there is an increase in the number of remote students, the number of universities involving them in the educational process is growing as well; a large number of international educational structures are being created, etc. The relevance of the study is the fact that the supports of management information processes of distance education is associated with the problem of effective distribution of system resources which are used in the transmission and processing of educational information. The aim of this study is a comprehensive analysis and development of methods of resources management in the organisation and operation of distance education systems. The scientific novelty of research: formalisation of information management processes in the system of distance education, taking into account the resources constraints of the educational system and the requirements of effective management. The authors conducted a study of educational information and reference resources for distance education. Reviewing the results, it is advisable to focus on the implementation of functional elements that increase the interactivity of the site.

1. Introduction

In the modern world, distance education is rapidly gaining popularity and is more and more being applied at the compulsory levels. The development of distance learning in the Russian Federation is an acute problem today, when all the educational organisations of the country are placed into lockdown in order to prevent the spread of the coronavirus. The quality of education should not decline, but ideally it is expected to be increased, due to the fact that this is consistent with the scope of sustainable development. The UN adopted the Sustainable Development Goals in 2015 and Goal No. 4 'Quality Education' is one of them (UN, 2014). On the other hand, it should be noted that today is the age of technology, which can be characterized by the massive amounts of data (Martins et al., 2018), which must be properly structured, analysed and accurately presented so that citizens will be able to take an advantage of this information sets (Morea et al., 2018). Modern education is the integration of content and learning technologies (Pavlicheva et al., 2019). The understanding of this fact allows to consider distance education as one of the additional opportunities to form an individual educational plan for each student. Information and communication technologies modify education at different levels. There are fundamentally new priorities, identified in the educational activity, the most important of which is the informational support of the management activity of educational organisations (Pavlicheva, et al., 2019). One of the levels at which Information and communication technologies played a key role over the past three decades is the management and distribution of educational resources and the provision of information to students and teachers or professors, that is often called the Education Management Information System.
Consequently, educational organisations are involved in the implementation of information systems and technologies that allow more efficient management of their resources. At the same time, information technologies also allow students to interact actively with the entire area of their courses (professors, study

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materials, assessments and colleagues), which affects positively the efficiency and success of both parts (Vicent et al., 2015). One of the functions of information data use consists in supporting decision-making in the field of educational policy (Davis et al., 2014).

The modern education system in Russia often results in young people not choosing a field which might be interesting for them in their future studying and working activity. Most Russian students as in other countries study in the traditional way through programs designed for a wide range of individuals (Martins et al., 2018) and without taking into account individual characteristics (Collins et al., 2018). Another challenge is the precise meaning of the word 'like', which is difficult to determine between the ages of 7 and 18, people often change their minds during the learning process (Drewes et al., 2006). A young person's choice of where to specialise should be facilitated by a systematic data analysis and include the employment of information technologies.

In addition, an important point in the management of education is the usage of competitive strategies among students, as well as engaging them in problem-solving in the area of their academic interest. This determines that the collection, processing and system analysis of the information at university in the modern world is becoming the basis for the formation of individual student learning strategies. Distance learning is one of the ways of implementing such approaches.

2. The construction of models of the educational process

Education is the transfer in the process of communication of knowledge and experience between those who possess them and those who acquire them (Bambaeeroo et al., 2017). The educational approach defines learning as an interconnected activity between teachers and students aimed at implementation of the leading functions of education. Education, from the point of view of management theory, is the cognitive activity of students, organised by the professor. The diagram in Figure 1 presents a fully-fledged model of the educational process.

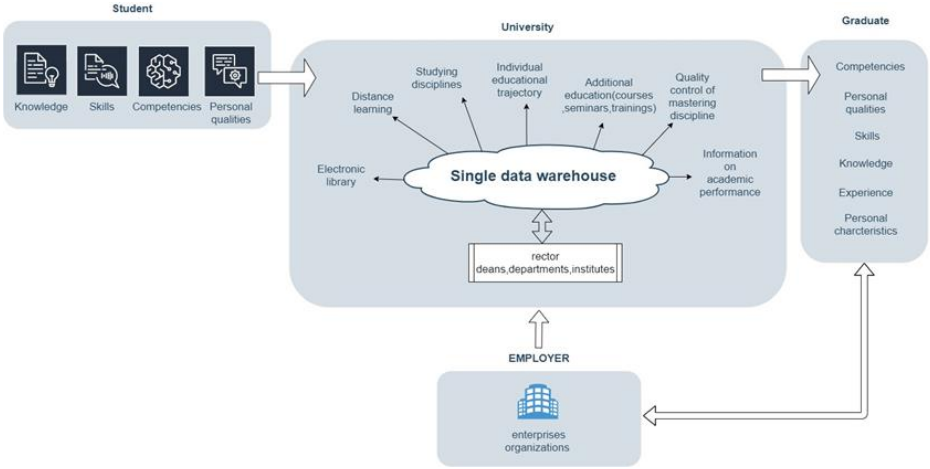

Figure 1: General model of the educational process at the university

At the first stage of this model is an applicant with his knowledge, skills, competencies, personal qualities (student's characteristics), at the last - a graduate with additional knowledge, skills, competencies, abilities, as well as more developed personal qualities. This knowledge and skills should be correlated with the needs of the employer. Distance learning is not just a form of the educational process, but it can be considered as an essential part of it. Distance learning is commonly reviewed as a specific mean of organising and managing independent activity in the educational process. In this regard, distance learning of students is not only aimed at mastering each discipline, but also at forming a variety of skills of independent work in educational, scientific, professional activity, the ability to take responsibility, solve problems independently, and find constructive solutions.

When creating an information resource for distance learning to describe the educational process, a framework model is used. Frameworks refer to structural-linguistic type models and are used for modelling and processing various knowledge of various objects.

The proposed framework model "Educational activity at the university" consists of frameworks "Student's characteristics", "Single data warehouse", "Graduate's characteristics" and "Person in charge". The development of the model was carried out with the usage of the conceptual and taxonomic analysis of the subject area.

In turn, the "Single data warehouse" framework is a network of frameworks - "Student's academic performance", "The system of management of academic disciplines", "Evaluation management system" etc. The "Student's

academic performance" framework consists of two frameworks: "Discipline", "General number of hours" and percentage of academic performance. The framework data contains the parameters necessary to determine the level of student achievement in a particular direction of study (Figure 2).

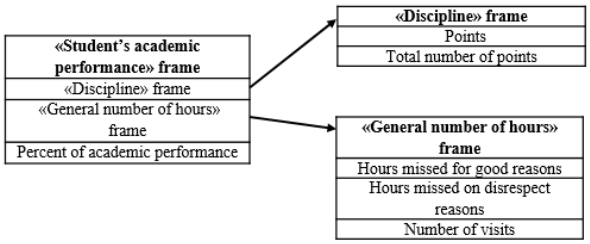

Figure 2: The "Information about student performance" framework

The "Evaluation management system" framework is a network of frameworks consisting of "Object of verification and evaluation", "Criteria for evaluation", "Subject of evaluation", "Control". This framework includes the characteristics of control over theoretical training and the embodiment of knowledge, skills in practical activities.

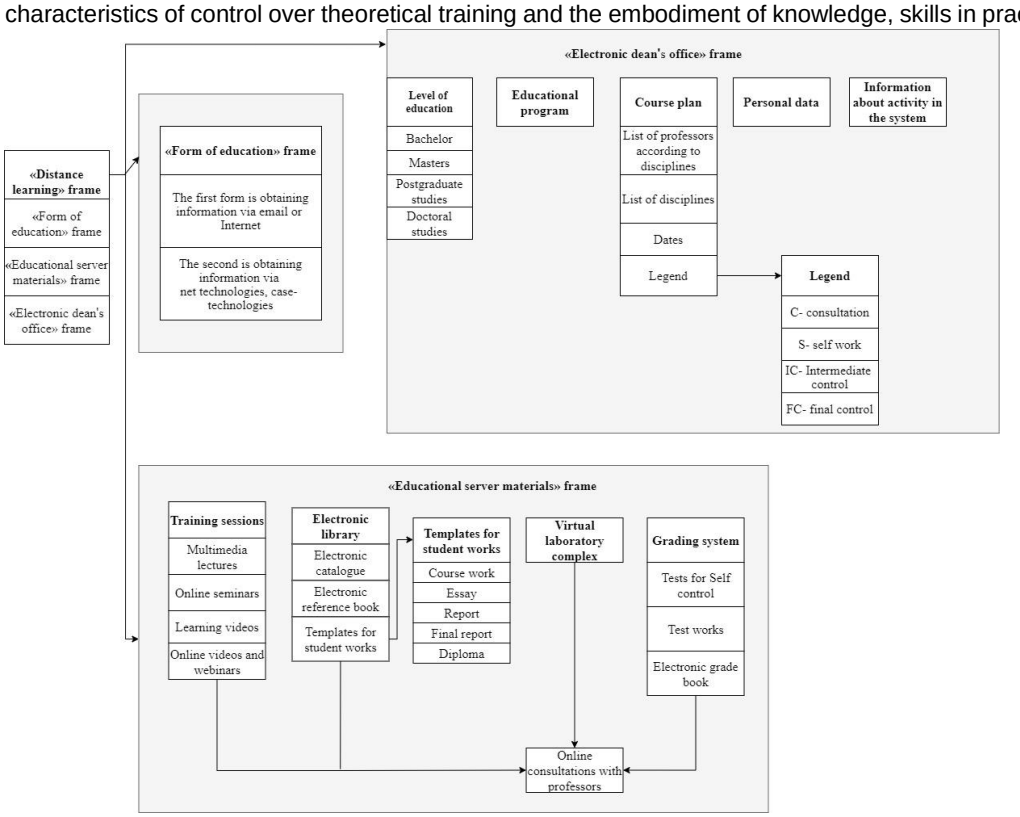

Figure 3: The "Distance Learning" framework

The "Distance learning" framework (Figure 3) contains three frameworks - "Form of education", "Educational server materials", and "Electronic dean's office". This framework contains parameters for establishing interactive communication between a student and a teacher without ensuring their direct meeting and independent development of a certain array of information on the chosen discipline with given information technology as shown in Figure 3.

The "Additional education" framework consists of four frameworks "Program", "Goal", "Target", "Category of listeners", "Volume" and such characteristics as content and price. They contain various parameters for choosing the fulfilment of new professional duties, for obtaining additional qualifications. The "Electronic library" framework consists of three frameworks "Electronic documents prepared by teachers and staff", "Electronic editions", "Electronic analogues of print media". These frameworks contain features for searching and obtaining the necessary literature for students learning. The framework "The system of management of academic

disciplines" is a network of frameworks consisting of "Module of disciplines", "Educational program", "Parts of disciplines", and "The system of management of educational process". These frameworks are interconnected and contain parameters for the accumulation of new knowledge within the relevant expertise.
The "Individual educational trajectory" framework (Figure 4) consists of three frameworks - the "Selection of the direction of trajectory" framework, the "Extra data" framework, and the "Educational trajectory" framework.

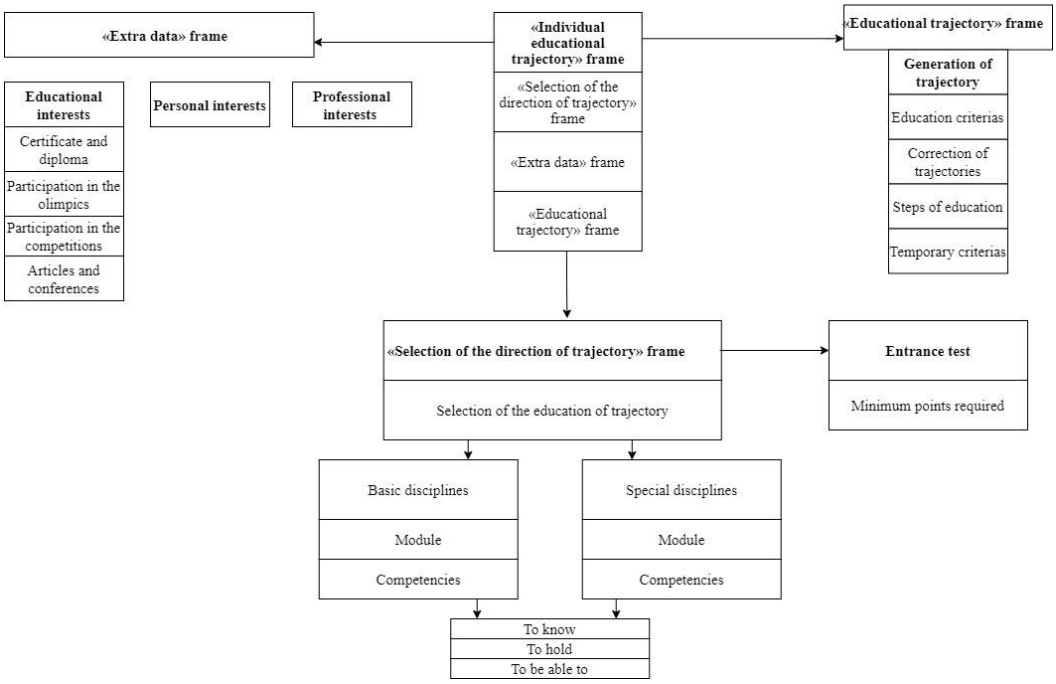

Figure 4: The "Individual educational trajectory" framework

This framework allows to select, develop and implement an individual educational plan, based on internal components - additional student data, individual achievements and personal educational interests (the "Selection of the direction of trajectory" framework), and external components - input testing and generating a trajectory. The combination of internal educational components and external ones will offer a varied educational route for each student. During the implementation of the individual educational trajectory of the student, refinement of individual components may occur, which includes possible adjustment. The development process of the implementation of individual educational paths is associated with the organisational aspect of the pedagogical process. First of all, the scale of the formation of individual educational trajectories is important, most often, the scale is limited to individual educational areas.
A separate module in the teaching of a chemistry student should be open educational e-resources (OER). Here several implementation methods can be seen: the use of the element of full-time study with the help of OER; reflection and explanation of the results obtained in studies of other scientists.
Open educational e-resources are quite common now. The study found that online education increased learning and suggested that students could learn most effectively when they work individually (Davenport et al., 2018). In distance learning, a large role is played by information resources. And choosing the right information resource is a complex and difficult task.

3. Selection of educational information and reference resources by quality criteria

Open educational resources, including topics on chemistry, green chemistry and chemical technology, were considered for comparative analysis. These resources contain the knowledge of the school, university and professional level. The objects of analysis were both Russian and foreign online publications. All the educational e-resources are supported by the project of the Federal Center for Information and Educational Resources (FCIOR), which aims to distribute materials and educational services to all levels and stages of education. Foreign English-language publications participating in the comparative analysis are included in the list of recommended Green Chemistry Network (GCN), established in 1998 by the Center for Green Chemistry at the University of York with funding from the Royal Society of Chemistry.

To assess the quality criteria of educational programs, a methodology based on a scale system was proposed. Each of the criteria is assessed on from 0 (zero) to 2 (two), where:

- 0 points are awarded in the absence of the criterion assessed at all;
- 1 point is awarded in the case of partial implementation of the assessed criterion;
- 2 points are awarded if the criterion is fully implemented.

The example of results of a comparative analysis of foreign educational e-resources are presented in the Table.

Table 1: Array of results of comparative analysis (Foreign e-resources)

	Open Educational Resources by School: Chemistry (CSU Bakersfield, 2020)	Open Educational Resources by Subject Disciplines (WCC Library, 2020)	Common Open Educational Resources (ISKME, 2020)	Open Educational Resources (Mt.SAC Library, 2020)	Chemistry for life (ASC, 2020)
	1. Criteria for evaluating functionality				
Forum	0	0	2	0	0
Visible attendance counter	0	0	0	0	0
Feedback Tools	2	1	2	1	1
Site search Box	2	2	2	2	1
Hyperlinks	2	0	2	2	0
Additional Interactive Tools	2	2	2	2	1
	2. Criteria for evaluating the structure of the interface				
Hierarchical structure	1	2	2	2	2
Subordinate structure mapping	0	1	2	0	1
	3. Criteria for evaluating the design of the interface				
Colour scheme	1	1	2	1	2
Readability of texts on the proposed background	2	2	2	2	2
Font consistency in headers, texts, buttons	2	2	2	0	2
	4. Criteria for evaluating substantive characteristics				
Site presentation (general description, goals, objectives)	2	1	2	2	2
Site manual	2	0	1	0	2
Interdisciplinary approach	1	1	2	2	1
The relationship between local and global	1	1	1	2	1
Total score	**20**	**16**	**26**	**18**	**18**

Among the selected criteria for assessing quality, the following criteria are implemented in most of the compared resources: hierarchical structure - 20 points out of 22; site search window - 17 points out of 22; readability of tests against the proposed background - 17 points out of 22.

According to the average number of points scored per criterion in the group, the criteria for evaluating the structure of the interface show the best result. On average, one indicator accounts for 13 points out of 22 possible. The least number of points was gained by such criteria as a forum, a visible traffic counter and a guide to using the site. On average, indicators for assessing the functionality of educational Internet resources are rather poorly implemented.

Among the analysed Internet resources, the best in terms of the number of fully implemented evaluation criteria was the English-language website «Common Open Educational Resources» (ISKME, 2020), which scored 26 points out of 30 possible. The resource gained a leading position immediately according to the criteria for evaluating functionality and for evaluating the design of the interface. However, the site does not have a visible attendance counter. Among the Russian-language Internet resources, the site «Unified Collection of Digital Educational Resources» (EDU, 2020) turned out to be the unrivalled leader, scoring 22 points out of 30.

The least number of points - 9 out of 30 possible - was scored by the Internet portal for Russian-speaking users «I am going to a chemistry lecture» (J.Chemiya, 2020) in which there are practically no criteria for evaluating the content characteristics, neither the criteria for evaluating the functionality of the Internet resource.

A comparative analysis of Russian and foreign educational Internet resources in the chemical field has the most implemented criteria for evaluating the design and structure of the interface. The criteria for evaluating functionality, such as having a forum and a visible attendance counter are most poorly implemented.
Taking into consideration the above results of a comparative analysis of educational reference and information resources in the developed Internet resource in the chemical field, it is advisable to focus on the implementation of functional elements that increase the interactivity of the site.

4. Conclusions

This article analyses and presents a model of educational activity of the teaching and academic standards at the majority of universities in the Russian Federation. Frameworks have been proposed to describe a general model of the educational process at the university. Frameworks describe the components and their interrelationship for visualisation (Figure 1-4). The core principles must lie at the individual qualities of the students and the totality of objects and subjects of the educational system. The development of the model was carried out with the usage of the conceptual and taxonomic analysis of the subject area. One of the essential components of the frameworks is distance learning that needs to be well-established in order to meet all the level requirements of the academic educational systems in the majority of countries. It was concluded that open educational resources play an important role in the remote educational process of chemistry students at all levels of academic cycles, as long as a student has free access to all the educational materials. The English-language reference portal “Common Open Educational Resources” (ISKME, 2020) meets the selected criteria to a greater extent. This portal should be accepted as a model of the structural design of the interface and the level of content characteristics.

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