Original Article

Digital environment components for the formation of students' information and analytical skills

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ABSTRACT

With the development of information society and the active use of distance learning technologies, the students' information formation and analytical skills become increasingly important. The goal of the present study is to develop criteria for selecting the digital environment components for the formation of information and analytical skills of students in individual educational trajectories. The authors conduct an analysis of scientific literature on the problem of the formation of students' information and analytical skills. As a result of this research, three stages of work with information are identified: information search, reproductive and productive transformation of information, and heuristic transformation of information. Based on this theoretical foundation, a codifier of students' information and analytical skills is developed. The criteria for the selection and design of digital educational environment components are identified: modular nature, individualization of learning, structuring the tasks following the information and analytical skills codifier, providing a student with initial information for work, evaluating the level of formation of information, and analytical skills using the developed matrix.

Keywords: information and analytical skills, individual educational trajectory, program module.

Introduction

Throughout our life, we communicate with many people [1-3]. The active transfer of the advanced developments of the UNESCO into educational activity is highly important for integration into the world educational space. The development and use of information and communication technologies (ICT) in providing high-quality education for the future have become increasingly valuable. The ideas of the UNESCO were reflected in the current educational standards in Russia. For example, information competency is included in the standards as one of the educational results. The formation of information competency, a crucial part of which is constructed by the information and analytical skills, is essential in the education of a modern person. Scientific studies examine several similar concepts, namely "information, and analytical competency" understood as the readiness to interact with information in the information society adequately and effectively [4], "information and analytical skills" interpreted as skills allowing to effectively search, process, and critically evaluate information, as well as control one's cognitive activity, etc. [4, 5].

The concept "information and analytical skills" is well-formulated and methodically represented in the scientific literature in the context of information and analytical conception. Many authors associate these skills with the ways of working with text information, for example, the search, analysis, evaluation, transformation of text, and reflection on it [4, 5].

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In their analysis of the process of students' work with text information, M.L. Kusova and S.V. Plotnikova identify the information actions in working with an educational text (information request; the search for an information source; pre-text processing, informed choice of the information source; extraction and understanding; post-text processing and interpretation; control and evaluation of the results of information activity) [6]. Meanwhile, E.Iu. Khramkova indicates the types of activity at various levels of work with an educational and scientific text. O.V. Iarom's works cover the logical processing of information and discover the mechanism of understanding the text [7].

In some works, analytical skills are distinguished into a separate category. V.A. Slastenin defines analytical skills as a complex set of procedures and a system of analytical actions and operations. I.G. Ovsiannikova believes that analytical skills present an integral unit of the pedagogical process that ensures the unity of the pedagogical activity components [8].

In foreign literature, information and analytical skills are typically distinguished with more focus being put on analytical skills and the formation of critical thinking (M. Bezanilla, R. Ennis, etc.) [9-12]. Many authors (E.V. Naznachilo, etc.) link information and analytical skills together and distinguish the concepts "information and analytical activity" and "information and analytical culture" [13, 14]. These concepts are similar in meaning and differ to a certain extent in the structural elements [4, 15]. In our study, we will operate with the concept of "information and analytical skills".

Researchers examine various aspects of the formation of information and analytical skills.

The conceptual basis for the formation of information and analytical skills is formed by the systemic approach (Ludwig von Bertalanffy and others) in the context of the systemic and functional component, the activity approach (A.N. Leontiev and others) in the aspect of gradual formation of skills in the process of learning activity, the reflexive approach (V.I. Slobodchikov, O.A. Mitrakhovich, and others), which involves the formation of reflection as an important quality of a teacher on all stages of learning, and the logical and didactic approach (V.A. Slastenin and others) as the substantiation of deploying the cognitive function of scientific and theoretical knowledge [15, 16].

O.A. Mitrakhovich links the information and analytical skills with universal learning activities [15].

Many authors have been developing the structure, specific characteristics, and typology of exercises for the formation of information and analytical skills at different levels of learning. N.D. Zhilina and L.D. Tarenko believe that it is necessary to implement development-inducing exercises that should be realized using information technologies [17].

A.B. Klimova developed a system of information and analytical skills, provided its substantial characteristics, and identified the major types of skills: information search, analysis, critical evaluation, creative processing, and reflection [4].

S.A. Mulikova and G.A. Dzhumekenova analyzed current professional educational standards and identified the skills university alumni should possess (the components of students' information and analytical culture). The authors believe the integration of information and educational environment in the educational process to be a crucial condition for the formation of these skills [13].

Although researchers have examined various aspects of the formation of information and analytical skills, we can note that a clear universal classification of these skills is still lacking.

One of the approaches linking personality development and the formation of any type of skills with the concept of an educational environment is the environmental approach. The problems of digital, information and educational, or virtual environment were addressed [18-22]. We shall understand the digital educational environment as the system of educational components of programs corresponding to certain criteria and promoting the formation of certain skills. It should be noted that the problem of creating a digital educational environment contributing to the formation of information and analytical skills is underdeveloped and a system of criteria for choosing the educational program components to integrate into this environment is lacking.

In modern education, the digital educational environment is becoming the leading means of individualization of learning.

In their publications on individual learning, A.V. Khutorskoi, M.A. Shemanaeva, and colleagues refer to the concept "individual educational trajectory". The authors believe an individual educational trajectory to be the way of realizing the personal potential of every alumnus in the education setting, as well as a set of measures, techniques, and forms of organizing individual activity that implement numerous technologies of educational activity and focus on achieving common goals in diverse personally important content [22-24].

In our understanding, the individualization of education in the digital environment conditions may include the following aspects:

- the opportunity of presenting students with a system of tasks of different levels;
- students' choice of an individual pace of work on multistage tasks or a set of tasks.

In our previous studies, we substantiated using students' psychophysiological indicators (the indicators of visual-motor reactions) as criteria for creating individual educational trajectories [25, 26].

Therefore, the problems of identifying and classifying the information and analytical skills within the information and analytical conception, the problems of creating individual educational trajectories, and the problems of selecting or designing the components of the digital educational environment remain relevant. The system of students' information and analytical skills is underdeveloped and the structure and specifics of the digital educational environment allowing the formation

and diagnostics of individual educational trajectories are not identified.

The goal of our study is to develop the criteria for selecting the components of a digital educational environment for the formation of students' information and analytical skills in the conditions of individual educational trajectories.

Materials and Methods

To clarify the concept of students' "information and analytical skills" and develop the criteria for selecting the digital educational environment components for the formation of said skills, we conducted theoretical literature analysis. Based on the developed codifier of students' information and analytical skills, we identified the criteria for selecting the educational program components contributing to the formation of the information and analytical skills of students in the digital environment.

✓ We also developed a method for the diagnostics of information and analytical skills based on performing operations with text and carried out the diagnostics using this method. The evaluation of each skill was conducted using the scale ranging from 0 to 2: 0 – not formed, 1 – formed incompletely, 2 – formed. Thus, the study participants could receive from 0 to 34 points. As a result of the diagnostics of the level of formation of information and analytical skills, the students were divided into three groups: high level – from 24 to 34 points; average level – from 13 to 23 points; low level – from 0 to 12 points.

Results

The first stage of the study involved developing the information and analytical skills codifier. S.A. Mulikova and G.A. Dzhumekenova [13] analyzed such skills as the components of information and analytical culture in the context of the requirements of educational standards. However, they did not provide a systemic classification of these skills.

A system of information and analytical skills is prevented in A.B. Klimova's work. We generally agree with the logic of the author's scheme, i.e. with the notion that a system of information and analytical skills should be based on the sequence of executing the steps of interacting with information [4]. However, we argue that, first, the number of groups in which the skills are divided in Klimova's scheme is too large and, second, certain skills identified by the author will be difficult to diagnose in practical and scientific activity while the development of methods and means for the formation of any results requires its effectiveness to be measurable.

Based on the traditional algorithm of working with information (search, processing, storage), we developed our codifier of information and analytical skills. The stage of storing information was excluded from our classification due to not being relevant to it and the information processing stage was divided into two stages, the first one corresponding to the technical side of information processing and the second one being based on creativity.

Therefore, we identified three main stages in the process of working with information: information search, reproductive and productive transformation, and heuristic transformation.

The information search stage involves the skills of searching for information sources, selecting the necessary information from the discovered sources, and compiling information.

The stage of reproductive and productive transformation of information requires the skills of productive reading and identifying the main idea, dividing the text into sections and formulating titles, processing numerical data, performing calculations, and creating tables, diagrams, and schemes.

The stage of heuristic transformation of information involves the formation and implication of the following information and analytical skills: comparison, analysis, synthesis, abstraction, generalization, specifying, systematization, and presenting the processed information. Thus, aside from the ability to perform basic operations of thinking, this stage includes the skills of presenting information, i.e. the ability to document the results of work at all stages of working with information. Since this skill is undoubtedly creative, dividing it into a separate category would not be rational; therefore, it was classified as a heuristic skill. The codifier could be presented in the following manner (Figure 1).

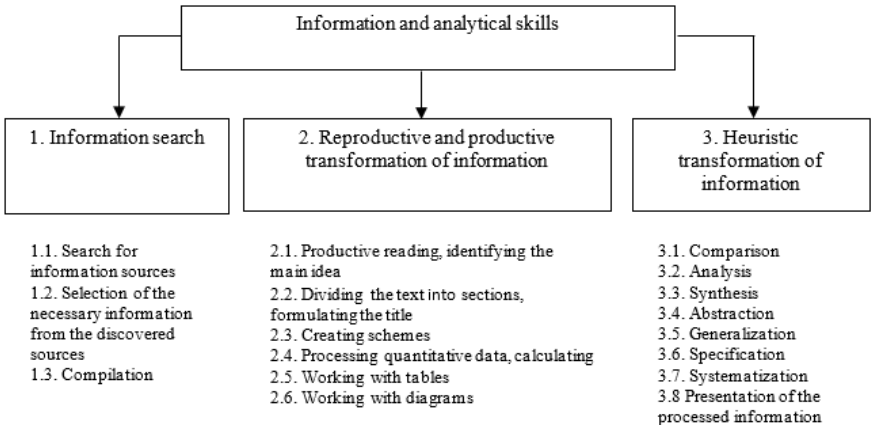

Figure 1: Information and analytical skills codifier

Using the developed method, we conducted the diagnostics of information and analytical skills of 58 first-year full-time students of the South Ural State Humanitarian Pedagogical University studying in pedagogical programs. The low and average levels of formation of information and analytical skills were found to be predominant in the studied sample (53.4% and 27.6% of students at each level, accordingly). Therefore, the problem of improving the effectiveness of the formation of information and analytical skills remains acute.

We propose using tasks constructed based on the skills codifier developed by us to promote the formation of information and analytical skills in university students. In the conditions of development of the information society and the improvement of information technologies, completing these tasks using special program modules is not only necessary but also realizable.

To support the laboratory work conducted as a part of the discipline "Age anatomy, physiology, and hygiene", we designed and implemented the program module "Student's somatic health passport" (certificate of state registration of a computer program No. 2020610839 of January 21, 2020). Said laboratory work is based on two methods of evaluating a person's physical condition (the method of standards and the index method) and involves performing various activities: studying theoretical material, taking measurements, and performing calculations. The work results in a report containing all the obtained results and conclusions made based on them.

The designed program module and the technology of working with it were analyzed to identify the information and analytical skills that can be formed using it.

At the beginning of the work, a student enters their data into the program: first and last name, age, and sex. This data is automatically included in the report, and the sex parameter is necessary for performing calculations since the standard indicators of physical development depend on it. The goal of the laboratory work, the equipment necessary for it, and the basic theoretical concepts are entered in the same form.

Further on, students collect individual starting data for further calculations working in pairs and using additional measuring equipment and guidelines for carrying the measurements out received by clicking on the name of the corresponding method. The starting date is necessary for evaluating one's physical condition via both the method of standards and the index method.

The following information and analytical skills that are formed and applied at this stage can be identified in the process of completing this task:

- productive reading, identifying the main idea;
- processing numerical data, performing calculations;
- working with tables;
- comparison;
- abstraction;
- presenting the processed information.

To evaluate physical development through the method of standards and creating a physical development profile, a student needs to fill in the following table (Figure 2).

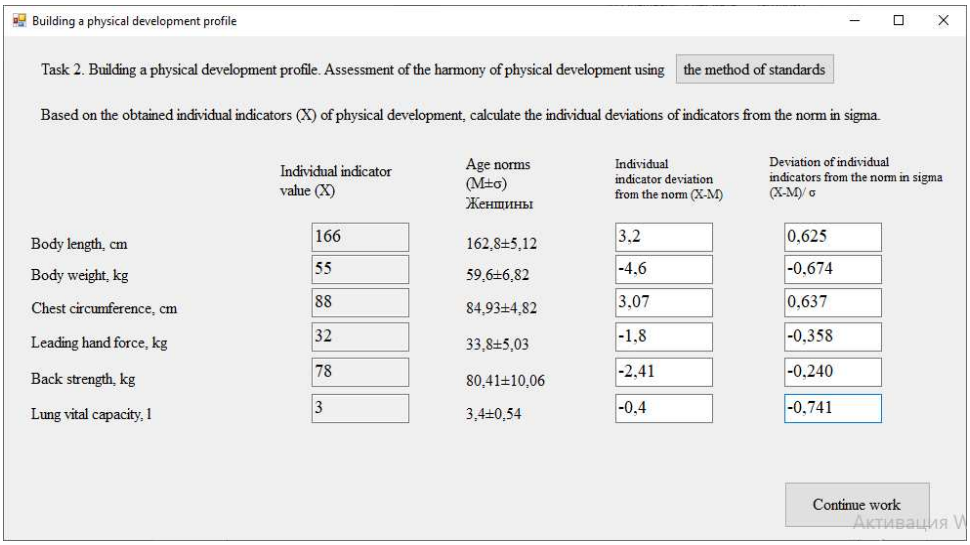

Figure 2: Task No. 2: an example of calculating the individual deviations of indicators from the norm

A part of the data is filled in the table based on the measurements taken at the previous stage and the table of standards of the relevant physical indexes (the data is different depending on the student's sex). Two of the indexes are left for the student to calculate and enter the corresponding table cells themselves. The results of calculations are checked automatically and the student is allowed to proceed to the next task only if all the calculations are correct.

Before performing calculations, the student needs to familiarize themselves with the essence of the method of standards since afterward, they will have to make conclusions based on the data of the measurements, calculations, and the final physical

development profile and enter them in their report on the laboratory work.

Thus, the first stage of work engages the following information and analytical skills:

- productive reading, identifying the main idea;
- processing numerical data, performing calculations;
- working with tables;
- comparison;
- presenting the processed information.

A graphical model representing the individual's physical development profile is automatically created based on the student's measurements and calculations (Figure 3). Having studied the methodical materials, the student has to conduct an evaluation of physical development and save the graph for further use in preparing the report. At this stage of the work, the evaluation is carried out by choosing the corresponding level of physical development from the proposed list, but the student has to justify their choice in the report on the work, the student has to justify this choice.

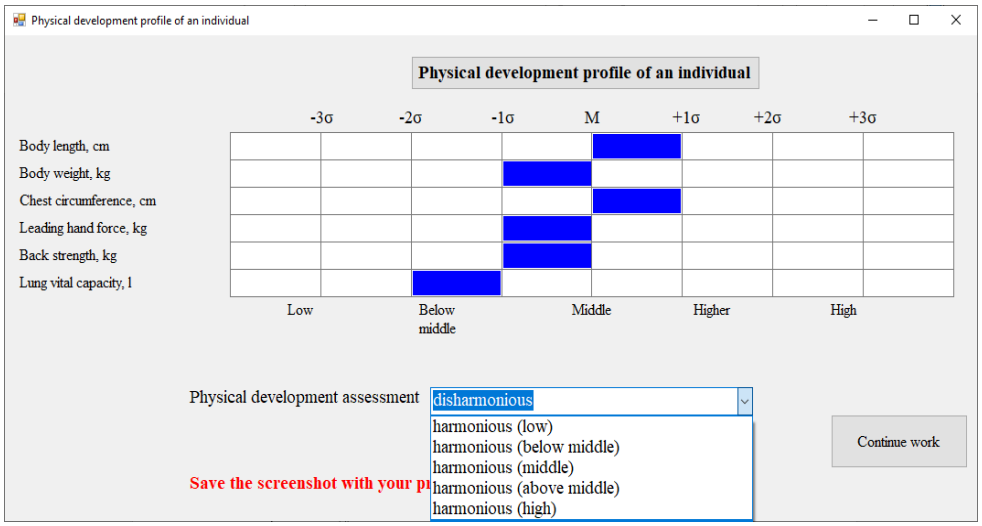

Figure 3: An example of an individual's physical development profile

This stage of work is accompanied by the formation and use of the following skills:

- productive reading, identifying the main idea;
- processing numerical data, performing calculations;
- working with diagrams;
- comparison;
- generalization;
- systematization.

The next stage of the laboratory work involves evaluating physical development via the index method. Using theoretical materials, the student has to calculate the body mass index (Quetelet index II) and conduct an evaluation of physical condition (Figure 4). Next, the Rohrer index is calculated and evaluated similarly.

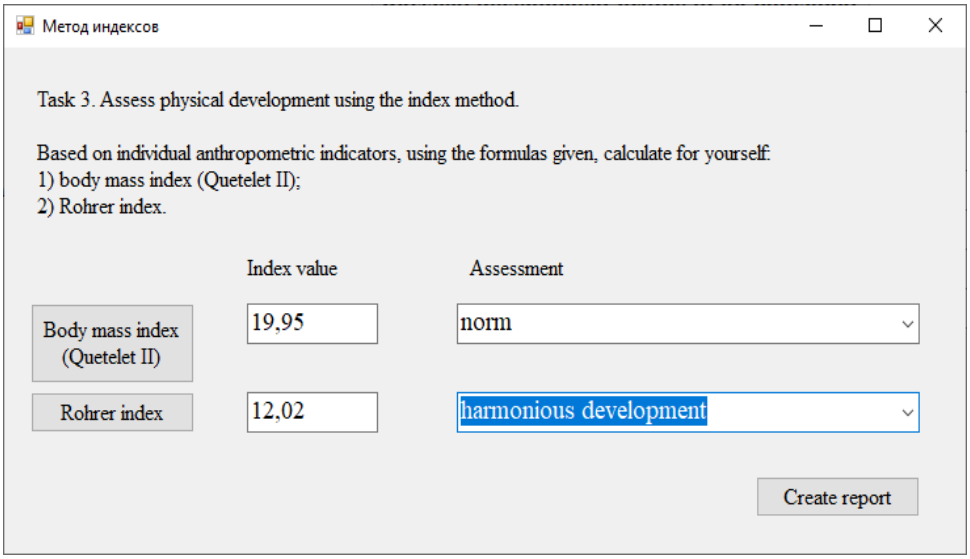

Figure 4: Task No. 3: an example of evaluating the physical condition via the index method

The process of completing these tasks involves using the following skills:

- productive reading, identifying the main idea;
- processing numerical data, performing calculations;
- working with tables;
- comparison;
- generalization;
- systematization;
- presenting the processed information.

The laboratory work is concluded with a report, a template for which is created automatically after the student completes all the tasks. The report includes the topic of the work, its goal, the deployed methods, the main data acquired in the course of the work, and the results of its express-evaluation. At this stage, the student's objective is to document the conclusions on the results of their work, for instance, on how the conclusions on harmonious or disharmonious development were made, as well as the summary of evaluations obtained through different methods.

The completed report can be saved in a format compatible with MS Word for the student to edit it if necessary and insert the previously saved graph illustrating the physical development profile (Figure 3).

Reporting presents the final stage of the work and is accompanied by the formation and use of the following skills:

- comparison;
- synthesis;
- generalization;
- systematization;
- presenting the processed information.

The information and analytical skills formed and deployed in completing the different stages of the laboratory work can be presented in a matrix (Table 1).

Table 1: Information and analytical skills matrix

Stage	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8
1	+	–	–	+	+	–	+	–	–	+	–	–	–	+
2	+	–	–	+	+	–	+	–	–	–	–	–	–	+
3	+	–	–	+	–	+	+	–	–	–	+	–	+	–
4	+	–	–	+	+	–	+	–	–	–	+	–	+	+
5	–	–	–	–	–	–	+	–	+	–	+	–	+	+

It can be noted that the process of completing this laboratory work in the digital environment contributes to the formation of most information and analytical skills of the second and the third groups of the codifier. As previously stated, the first group of skills is mostly engaged in working with theoretical material.

Discussion

The content of the tasks of practical and laboratory works on different disciplines demonstrates that such works may have the following characteristics. First, it is possible to carry them out in the form of educational program modules or to select the existing program modules to integrate them into a single digital environment. Second, completing the set of tasks included in such works ensures the formation and development of all information and analytical skills. The following criteria were identified for developing the tasks and selecting and designing the digital environment components:

1. Modular form: each task can be viewed as a separate module, and the software product presents a module as well.
2. A student obtains and processes certain information in the process of completing the task.
3. The information may be embedded in the program module (selected by the teacher and presented to the student in a finished form) or the student may have to search for information sources and select the information necessary for completing the task on their own.
4. The task should be constructed in a way that would require a student to perform as many different operations with the obtained information as possible to complete it.
5. If possible, the operations with information involved in a single task should be based on the information and analytical skills from different groups presented in the codifier.
6. The work should be concluded with a report containing the results of the work with information at all the stages, as well as the "new" information attained.
7. The program module should contribute to the individualization of learning, i.e. allow students to complete tasks at their own pace, contain "tips" on completing the tasks, be composed of tasks of different levels, etc.

The analysis of the structure of the educational software product "Student's somatic health passport" (certificate of state registration of a computer program No. 2020610839 of January 21, 2020) allowed us to formulate the principles of designing educational software products that allow the formation of information and analytical skills.

It can be noted that, on the one hand, the tasks aimed at the formation of most skills we indicated in the codifier can be designed for many disciplines and realized through special software. On the other hand, designing the tasks that allow developing all the skills appears quite difficult and we, therefore, consider it inexpedient. For instance, the skills included in the first group (1.1, 1.2, 1.3) and a part of the skills from the second group (2.1, 2.2, 2.3) mostly develop in work with theoretical material although they are also indirectly formed and implemented in practical tasks while the formation of the remaining skills of the second group (2.4, 2.5, 2.6) occurs in completing laboratory and other similar works. The skills of the third group are formed, developed, and used both in working with theoretical material and completing practical tasks. However, we must also account for the fact that each task can only focus on the formation of a part of these skills.

An important aspect to be considered in selecting and designing program modules is the individualization of learning which means that such software products have to contribute to the formation of individual learning trajectories.

Conclusion

In this study, we followed the requirements of the Federal State Educational Standard for higher education indicating that the functioning of the electronic information and educational environment is ensured by appropriate means of ICT. The program module we developed in the course of this study presents one such means that primarily contributes to the formation of the universal competency of searching for information, its critical analysis and synthesis, and deploying systemic approaches for solving the presented tasks.

We concur with the conclusion that the digital environment acquires the leading role not only in the formation of students' information competency but also in the individualization of learning.

The suggested principles of task structuring can be implemented as a general strategy for the realization of the content of educational disciplines of an educational program.

The presented software product can be viewed as one of the digital environment modules designed for the formation of students' information and analytical skills. We foresee the further perspective of developing program modules that would allow structuring the content of an educational discipline in the context of information and analytical skills formation.

Individual educational trajectories would allow students to master the discipline following their typological characteristics and the initial level of knowledge which, as we believe, can have a positive effect on the quality of education in general. The evaluation of the effectiveness of the presented program module and the principles constructing its basis presents a prospect for further studies.

Therefore, the effective formation of students' information and analytical skills calls for a systemic approach to selecting and designing tasks and creating a universal digital environment ensuring the systemic formation and development of said skills in the conditions of creating individual educational trajectories.

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