

Data Visualization as a Required Component of ICT Competences in the Head of an Educational Institution

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Abstract: The effectiveness of management decisions depends on the quality of analysis of data on management, first of all. In modern conditions, these data are formed mainly on the basis of monitoring and have very significant amounts. The effectiveness of the analysis of such data depends on the form of their presentation. The most effective form is the visual form of presentation, it allows one to select the logical and causal relationships in the data array. This means that one of the most important skills required for a modern leader is the ability to work with large volumes of weakly structured and unstructured data and extract professionally relevant information from them using visualization tools. This ability is advisable to consider as a necessary element of ICT competencies in any modern leader.

1. Introduction

The development of production, science, and education in the Russian Federation in the coming years will be determined by the “Strategy of Russia’s Scientific and Technological Development” [1]. This strategy originated in the context of responses to big challenges. According to the Strategy, a set of problems, threats, and opportunities is objectively requiring a response from the state, the complexity and scope of which is such that they cannot be solved, eliminated, or implemented solely by increasing the resources.

One of the fundamental challenges of modern digital society is the exponential growth of unstructured data, which soon will have a significant impact on all areas of human information activity. Under these conditions, the further development of ICT content is necessary, which would include tools allowing one to work effectively with semistructured and unstructured data.

2. Materials and Methods

In the late twentieth and early twenty-first centuries, the technology base expanded. On particular, cognitive, biological, and other technologies emerged. Information technology played a dominant role in this process, forming a common convergent context. A special role in this process is played by data transformation technologies into information, which are a component of cognitive information and communication technologies [2]. The methods used for solving this task are based on the use of these technologies, primarily.

3. Results

The activity of the modern head of an educational institution is connected with receiving, transferring, analyzing, and generating various information. First of all, it is connected with the conduct and analysis of various monitoring, on the basis of which effective practices are selected and management decisions are made. On the other hand, the manager receives a wide variety of data, which he must necessarily comprehend and process. The peculiarity of modern society is that the amount of poorly structured and unstructured data becomes critical and “blurs” stable semantic connections. Under these conditions, the need

to expand information and communication competencies (ICT competence) of the head of an educational institution directly related to his professional activity arises.

ICT competences are traditionally considered as new literacy, which includes, first of all, the skills of active, self-processing of information by a person, making fundamentally new decisions in typical and non-standard situations, in particular using information technology tools, as well as technical skills of computer input, operating with on-screen representations of information objects and models. These competencies, in particular, include:

- The ability to present information in the form of an adequately set task, in particular, with the help of presentations;
- The ability to process information according to certain rules in accordance with the goal, in particular, using information tools (text, graphic editors, etc.);
- Store information, using databases in particular;
- Be able to use information to solve practical problems;
- Be able to transmit information using electronic communications [3], [4], and others.

On the other hand, a number of authors (S. V. Simanovich, etc.) have long emphasized the fundamental difference between the concepts of “data” and “information”, although the motives for introducing such a distinction often did not coincide. For example, from the point of view of S. V. Simanovich, information is data plus methods for processing them, while the data carry information about the object being studied, which must be “extracted” with the help of certain methods [5]. Such an understanding of data is close to their natural science interpretation, when the researcher is offered some set of data for analysis, obtained as a result of measurements, observations. In this case, the characteristic feature of the data is the absence of visible patterns. However, the existence of such patterns is assumed, and the task of the researcher is to find these patterns. Such a separation of the concepts of “data” and “information” is very important for the head of an educational institution. Receiving various data, he has to transform them into information, i.e. to find in the data some reflection of the real state of affairs, on the basis of which decisions can be made.

Methods and visualization tools are an effective tool for transforming weakly structured and unstructured data into information.

Accordingly, ICT competences in the head of an educational institution should be expanded by including knowledge, skills, and experience in the visualization of the above data.

The ability to visualize data is very important in the collective solution of a managerial task by brainstorming, which is often the case in crisis situations.

In these conditions, the participants of this activity must:

- Possess all the concepts of the subject area of this task, which contributes to its understanding and structuring;
- Have an ability to present this subject area in the form of visual images that are understandable to all participants in the collective solution of this problem;
- Have an ability to organize the interaction of all participants in a collective problem solving.

The development of data visualization skills has long been in the field of view of researchers [6] and others.

All these researchers say that building visual images of a given subject area significantly helps to see logical and causal relationships, and ultimately obtain the necessary information and make an adequate decision.

To this end, it is advisable to add a new component to the content of ICT competencies that includes the knowledge, skills and experience of visualizing unstructured and semi-structured data.

According to the tradition of the school of I. V. Robert, as well as other researchers, the content of competencies is revealed in three dimensions: knowledge, skill, and experience. The same applies to ICT competencies. The named component of ICT competencies could also be presented in the form of a table.

TABLE 1. KNOWLEDGE, SKILLS, AND EXPERIENCE OF ACTIVITY IN THE VISUALIZATION OF NONSTRUCTURED AND SEMI-STRUCTURED DATA.

	Knowledge	Skill	Experience
Data	Types of data to be visualized	Setting a management task, defining the purpose of visualization with the help of visual tools	The formulation of the goals in data visualization from the point of view of extracting management information from them
Choosing a visualization method	The main ways of visualization (for example, intelligence/maps)	The choice of adequate methods of visualization, from the point of view of the set managerial task	Implementations of selected visualization methods
Selection of visualization software	Opportunities of visualization software	Use the power of visualization software	Applications of software for creating visual images
Creating a visual image using the selected tool	Basic actions aimed at creating a visual image	Perform basic actions to create a visual image	Data analysis using visual images
Data analysis based on visual images	The fundamental differences between data and information	Analyze data and extract information from it.	Analysis of monitoring research data
Making management decisions based on data analysis	Management information basics	Formulate a management decision in the form of some algorithm	Implementation of management decisions in the information environment

The development of visualization skills has a significant impact on the ability to work with large arrays of semi-structured and unstructured data. This data can be recorded in the form of signs, diagrams or a picture. These visual structures play a key role in identifying internal links in the data array.

Practice shows that visualization within the framework of the formation of ICT competencies allows:

- Selecting, summarizing, and systematizing the data in the process of solving the problem;
- “Weeding out” superfluous, secondary information, which is of fundamental importance from the point of view of making management decisions;
- Bringing information as close as possible to the form in which a person perceives it.

The following criteria were chosen as criteria for assessing the formation of the indicated ICT competence component, in particular:

- The ability to organize large arrays in the general case, unorganized data in the form of structures of different types.

High level: possessing various data ordering methods; confidently distinguishing between different types of data; the ability to adequately represent each of the data types; using methods and means of presenting information.

Intermediate level: the ability to analyze data of various types; knowledge of basic approaches to their organization, but not confident use of standard data visualization tools.

Low level: not able to analyze existing data, does not own the forms of their visualization.

- The ability to extract information from the data array.

High level: the ability to extract the necessary information used for the formulation of the problem; the ability to distinguish and represent the relationship between the individual elements of the system; having various ways of obtaining and analyzing information; adequate evaluation of the information received.

Intermediate level: searching for information necessary for setting a management task is not effectively organized; the structure of elements and their interrelations is adequately understood; applying the known methods of data processing and evaluation; received information is not always adequately interpreted.

Low level: no ability to extract the necessary information from the available data array; no ability to see the relationship between the individual elements of the system in their interpretation.

- The ability to highlight the main, essential elements that are important for the formulation of management tasks.

High level: the task situation is clearly highlighted; the task is formulated, aimed at achieving the goal; good orientation in the structure of the elements that form the task situation.

Intermediate level: a necessary phenomenon is surely highlighted, but there are problems with its analysis; source data are correctly determined, but they cannot always be presented as conditions of the problem; individual elements are described quite clearly, but the description of the relations between the elements is difficult.

Low level: there are problems in identifying the phenomenon under study; when formulating management tasks, a variety of options is not always visible; there are significant difficulties in orienting in the elements included in the situation of the conditions of the management task.

- Ability to build and evaluate an information model that meets the conditions of this task.

High level: understanding the ultimate goal of solving a managerial task and determining the volume and quality of information necessary for solving.

Intermediate level: understanding the overall goal of solving the problem; lack of formed skills to receive information necessary to solve the problem.

Low level: lack of vision of the ultimate goal of solving the problem, no ability to find the information needed to solve it.

- Ability to develop, interpret, and use the information model and organize practical activities using this model.

High level: understanding the purpose of the given task and correct definition of the model necessary for its solution.

Intermediate level: the ability to find or develop a model only with a hint.

Low level: difficulty in determining the data set needed to solve the problem; difficulty in formulating the problem.

Mastering the information component of management, especially the ability to quickly extract information from incoming data, which allows one to adjust, and in other cases, change the management style of an educational institution. In our opinion, it is advisable to actively use the ideas and methods of synergetics for this. Synergetics is an actively developing theoretical direction represented in the national science by the works of E. N. Knyazeva, S. P. Kurdyumov, N. N. Moiseev, and others.

So, E. N. Knyazeva and S. P. Kurdyumov [7], justifying the need to use the ideas of synergetics in education, noted that the synergistic world view allows a new approach to the problem of effective management of the development of complex systems (cognitive, environmental, geographical, economic, etc.). The essence of the new approach to management lies in the fact that it is focused on something immanently inherent in the environment itself. In other words, in this approach not so much the subjective desires and preferences of the subject of management are realized, but the own laws of evolution and self-organization of complex systems.

From the point of view of synergetics, the inefficient management of the natural, cognitive, or social system is to impose on the system some kind of organization that is alien to it. In the best case, such management makes all human efforts vain, “going into the sand”, and at worst, it causes real harm, leads to undesirable and difficult to repair crisis conditions. We will present some points of synergetics that are important from the point of view of the approach discussed in this paper.

Self-organization is one of the key concepts in synergetics. In the aspect of control, this means control by establishing a resonance between the control action and the controlled system. Otherwise, the impact may reach the goal.

Data analysis, the ability to “convert” them into information is the most important prerequisite for identifying the internal patterns of development of a controlled system. To act most effectively, one must act at the right time and in the right place. We are talking about the resonance effects. In this case, the main thing is not the force (magnitude, intensity, duration, inclusiveness, etc.) of the control action, but its consistency with the own tendencies of self-structuring of a nonlinear medium.

A number of studies (V. V. Lukin [8] and others) showed that the modern educational environment in many respects functions as an open self-organizing system, in particular at the regional level. This is due to a number of circumstances. Municipal administration services function not only as tools to achieve certain goals, but also as a human community, each member of which has its own interests and needs, which do not always coincide with the goals of the organization. All socio-organizational processes are mediated by self-organization processes. The streamlining of professional and social relations in an institution is achieved not only through legal regulation and purposeful management, but also as a result of spontaneous interaction of the organization’s members among themselves through social and psychological communication and the development of unwritten rules, norms, customs, traditions, and values. Along with the formal structure in the institution, an informal structure is formed, which is based on different principles and sources of regulation of people's behavior. The results of the processes of self-organization are fixed in it, above all.

4. Discussion

The problem of information aspects of managing educational organizations is very important in the framework of a modern information society. Many researchers ([9] and others) discussed various aspects of this problem. At the same time, the problems of analyzing data about a control object using methods and means of visualization, in the context of making management decisions, still require research.

5. Conclusion

In modern digital society, the ability to work with unstructured and semi-structured data, to extract information from this data and use it to solve management problems becomes one of the basic skills. Accordingly, this means that the content of ICT competencies, the development of which is the responsibility of any manager of an educational institution, must be supplemented with knowledge, skills, and experience in the field of visualization of unstructured and semi-structured data.

The active use of visual images in management activities is based on the following skills: determining the type of data for visualization, choosing a visualization method, choosing a means of building a visual image, creating a visual image using the selected tool, extracting information from the provided data based on visual images, developing management decisions. The development of data analysis skills using visual images implies, in particular, the use of basic elements of a visual image: points, lines, shapes, directions, tones, colors, structures, sizes, scales, movements incorporated in visualization software (3D Studio Max, 4D Cinema, Maya, Poser, Visio Pro for Office 365, etc.).

Data analysis, the ability to convert them into information are the most important prerequisites for identifying the internal patterns of development of a controlled system. In order to act effectively, it is necessary that the control actions on the system correspond to its internal resonances.

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