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Methodology of Data-Driven Pedagogy and the Development of a Culture of Analysis of Educational Data in Pedagogical Communities

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Abstract

The application of the technology of big data analysis as an end-to-end technology of the National Research Initiative of Russia and its integration in the field of education and education management is being updated. The purpose of the article is to analyze the methodology and methods of analyzing educational data in education and ways of developing a culture of analysis of educational data in pedagogical communities. The study is based on a systematic and methodological approach based on the analysis of educational data (Educational Data Mining), and methods of intellectual analysis of educational data, which allows us to develop the methodology of "Pedagogy based on data." The results of the study: the methodological foundations of pedagogy based on data are characterized as a new field of pedagogical knowledge and practice. The methods of analyzing educational data are systematized depending on the subject of analytics. Pedagogical reflection is considered as the basis for the development of professional competencies of teachers in the analysis of educational data and organizational and pedagogical competencies in managing the quality of educational results of students. The methods of introducing teachers to the culture of the analysis of educational data are analyzed. The developed approaches allow developing the competencies of teachers in the field of analysis of educational data in practice.

Keywords: data-driven pedagogy; quality management of educational results; educational data analysis methods; pedagogical reflection; digital educational resources and educational data analysis services.

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Introduction

Educational data analytics are becoming a new tool for transforming the education system on the basis of the principle of personalization of training and human development, to improve the quality of educational results and educational management based on data. In connection with the development of electronic educational platforms, digital resources and services (NES services, MES (MES services, 2019), Digital platform "Education of Ugra" (2019), Portal "Petersburg Education" (2019), "Network City. Education" of Yakutia (The network city. Education. Sakha (Yakutia), 2019)), development of electronic reporting systems based on the results monitoring of education (for example: OO-1, OO-2 (GIVC Ministry of Education and Science. Federal Statistical Observation 2019-2020, 2019), the accumulation and systematization of educational data has become possible. Educational policy begins to be based on educational analytics: new analytical and managerial methods: a) development forecast based on a combination of data on education and human development; b) a method for revealing the structure and clustering of educational data; c) network analysis of "digital footprints" and analysis of educational data on a person's digital portfolio.

The lack of developed methodological approaches and technologies for the analysis of educational data does not allow the development of competency-based training programs for teachers in the field of analysis of educational data, complicates the implementation of the federal projects "Digital School" and "Teacher of the Future" of the National Project "Education" in Russia due to insufficient staffing potential competent in the analysis and interpretation of educational data, data-driven education management.

Purpose and objectives of the study

Analyze the methodology of data-based pedagogy and explore organizational forms and ways of developing competencies in the analysis of educational data among teachers and the culture of working with educational data in the pedagogical community

Literature review

Analysis of the current state of research in the field of evidence-based management and analysis of educational data (Educational Data Mining) can be structured in four directions:

1) research on the development of e-learning systems and electronic portfolios, digital footprints in education, including brick and click models (a mix of traditional and e-learning), electronic modular educational platforms (Modular Learning Environment) and digital twins in education (Digital Twin);

2) design and study of artificial intelligence technologies - analysis of educational data, including design and study of public educational data repositories;

3) a study of the development of methods for analyzing a new type of educational data (for example, a new method of social network analysis and predictive models of student performance using big data);

4) study of the structure of competencies, concepts and practices of the competence development of data analysis professionals in education, including research and evaluation of the effectiveness of programs (for example, "Big Data in Education", "Practical Learning Analytics", "Data, Analytics and Learning").

In the first area of research, we can distinguish the work on meta-cognitive science in education and the study of the development of cognitive tutoring on the analysis of behavioral patterns of schoolchildren in e-learning by Kiesler, Kraut, Koedinger, Aleven, & Mclaren (2011) and the work of Shchedrovitsky (2019) on the longitudinal analysis of educational achievements and individual educational progress of schoolchildren.

In the Russian segment of research in this direction, the works on the design of the electronic educational environment, revealing the methodological principles of the analysis of electronic educational resources and services, is distinguished.

In the second direction — the design and study of artificial intelligence technologies for the analysis of educational data, including the design and study of public repositories of educational data — the methodological works of Baker and Siemens (2012), Witten and Frank (Frank, Hall, Trigg, Holmes, & Witten, 2004), Ciresan, Giusti, Gambardella and Schmidhuber (2012) reveal the methodological principles and technologies of data analysis in human education and development.

In the third area, a study is made of the development of methods for analyzing a new type of educational data in the methodological and applied works of Al-Ajmi and Zimmerman (2005) and Siemens and Baker

(2012) disclose new methods of analysis of educational data - network analysis and forecast models of schoolchildren's performance using big data; analysis of value added data to improve schoolchildren's learning.

In the fourth area - the study of the structure of competencies, concepts and practices of the competent development of data analysis specialists in education - Sitzman, Elu, Koedinger, Corbett (2002-2013) disclose the results of a study of methodological design and evaluation of the effectiveness of professional development programs on the analysis of educational data, in particular cognitive tutoring.

Methodology

Methodological foundations in the field of analysis of educational data (Educational data mining) - methodological approaches:

a) research methodology for the development of e-learning systems and electronic portfolios, digital footprints in education, including the study of brick and click models (a mix of traditional and e-learning), the study Modular Object Oriented Dynamic Learning Environment (modular object-oriented dynamic training platforms) and Digital twin (digital twins in education),

b) the methodology of designing and researching artificial intelligence technologies - the analysis of educational data, including the design and study of public repositories of educational data,

c) research on the development of methods for analyzing a new type of educational data (for example, a new method of social network analysis and predictive models of student performance using big data),

d) a research methodology for the structure of competencies, concepts and practices of the competence development of data analysis professionals in education, including research and evaluation of the effectiveness of programs (for example, "Big data in education", "Practical learning analytics", "Data, analytics and learning").

In our interdisciplinary study, "Methodology for the analysis of big data in education and its integration into the training programs for teachers and heads of educational institutions in the logic "Pedagogy based on data"," Management of education based on data ", based on the integration of engineering, psychological and pedagogical, organizational and managerial subject areas of research fundamental problems that are of practical importance are solved:

1) a methodology (Fiofanova, 2020) and technologies for analysis and interpretation of data on education and child development are being developed, structured in the following areas:

- analysis and interpretation of data to predict student performance, individual educational progress;

- analysis and interpretation of data on the cognitive, personal characteristics of children, the characteristics of the motivational choice of training profiles for designing the content of electronic educational environments and individual educational routes;

 - analysis and interpretation of data on the quality of education based on the results of final certification of schoolchildren, the All-Russian test work, the All-Russian Olympiad for schoolchildren, international studies of the quality of education for the development of organizational and pedagogical decisions, managerial decisions to improve the quality of education, for evidence-based educational policy;

2) on the basis of the developed methodology and technology for the analysis and interpretation of educational data, methodological principles are developed for designing competency-based continuing education programs for teachers and heads of educational organizations in the logic "Pedagogy based on data" (Fiofanova, 2019) and "Education-based education based on data", which creates in turn, the conditions for the development of mass practice in the general education system and the competence of the analysis and interpretation of data in education, the use of the use of digital services for the analysis of educational data to develop organizational, pedagogical and managerial decisions in education;

3) the system of monitoring indicators of the general education system, its organizational and legal framework and statistical tools are analyzed and modernized, project proposals for modernizing the methodological and organizational and legal base of general education monitoring OO-1 and OO-2 are formulated, project proposals for the development of digital services are formulated analytical data on monitoring indicators of the general education system (Fiofanova, 2019).

Thus, a comprehensive solution of problems (research, monitoring, statistical, organizational and pedagogical) will allow us to develop a culture of pedagogical and managerial activity in the field of education based on the analysis of educational data.

Results

The methodological foundations of pedagogy based on data, as a new field of pedagogical knowledge and practice, are developing congruently with the development of new methods of analysis of educational data, depending on the subject of pedagogical analytics.

A systematic and methodological approach based on the analysis of educational data (Educational Data Mining) is developing in all countries of the world, in the last decade it has been actively in Russia. This approach involves the use of data mining methods and statistics of information produced by educational organizations and educational platforms (for example, "Russian Electronic School", "Moscow Electronic School", "Educational Platform of Ugra 5: 0", "Perm Electronic School", "Electronic School of Yakutia" and other digital educational platforms). A systematic and methodological approach based on the analysis of educational data (Educational Data Mining) allows you to explore the management of schoolchildren's learning on the basis of data (learning management system) and ways of organizing educational data for making organizational, pedagogical and managerial decisions in education (Big Data Management in Education) .

Methods of learning analytics (learning analytics) and analytical and statistical methods for the study of intelligent learning systems (Intelligent Tutoring System), methods of in-memory analytics in the study of "digital footprints" collected in the electronic journal, electronic diary, digital portfolio, in the student's personal account in MES, NES, etc., as well as in other logs for subsequent analysis. These methods allow you to develop and describe for subsequent use in educational practice the methodology and technology for the analysis and interpretation of educational data and data on child development. And also to develop, on the basis of these methods, the methodological foundations of the content of teacher training and the conceptual foundations of a new interdisciplinary branch of knowledge called "Data Driven Pedagogy".

Methods of analysis of educational data, including methods of traditional data analysis (Data mining): classification of educational data, their clustering (sequential pattern mining), the search for relationships in educational data (relationship mining), as well as the intellectual analysis of texts in the form of design and research work of students (Text-mining) allow you to design big data processing services in education and child development (at the federal, regional, institutional school level).

The methodology and technology for the analysis of educational data in the concept of "Data-based Pedagogy" (Data Driven Pedagogy) is based on a group of methods:

a)methods for predicting the value of a quantity of interest by predictor values: for example, predicting the results of final certification or Olympiad achievements of schoolchildren based on analysis of current academic performance data, participation in additional education programs, and choice by schoolchildren of the degree of difficulty of tasks and tasks to be solved during the lesson; forecasting the election of specialized training for schoolchildren on the basis of data on pre-profile samples and participation in the

competition for design and research work; forecasting Olympiad achievements on the basis of statistics of types and content of solved problems, etc.),

b)structure discovery methods reveal the structure, clustering algorithms in the educational data: for example, the structure of the lesson, taking into account the peculiarities of the organization of education of students with different types of educational motivation, the organization of education of students with different types of educational difficulties according to the results of independent diagnostics of the quality of education and verification works,

c) relationship mining methods establish relationships between variables in a data set with a large number of variables: for example, the relationship between attendance at lessons, including on-line training, and the educational results of students in the modules of the educational program, the relationship between the design organization activities of schoolchildren in the classroom and the results of the development of meta-subject competences based on the development of educational programs.

The development of professional competencies of teachers regarding the application of these methods of analysis of educational data allows teachers to be introduced to the culture of analysis of educational data and to solve the problems of hermeneutics of a new childhood (understanding of the personality of students by the teacher), the tasks of improving the quality of educational results (understanding of the basis of educational success of students by the teacher), the tasks of effective development management educational techniques, educational platforms and digital services (understanding the need new education development projects).

The psychological basis for the development of professional competencies of teachers regarding the application of methods for the analysis of educational data in educational practice is pedagogical reflection.

Pedagogical reflection is considered as the basis for the development of professional competencies of teachers in the analysis of educational data and organizational and pedagogical competencies in managing the quality of educational results of students. Reflection as a meaning, fixing the experience of self-awareness, is an important component of professional activity. In the thought-research approach, reflection is explained as the result of a change of one mental means to another and reflection is the result of a change of position (Shchedrovitsky, 2005). That is, in the practice of applying the methods of analysis of educational data and comprehending the results of the analysis of educational data, teachers form a managerial and pedagogical position. The position associated with the new organizational functions of the teacher in relation to the developing person and his educational environment, the quality of his educational results. For example, in reality you can often hear: "Ah, this Petrov is not capable of anything. What can I do? "- in connection with the limitation of mental tools and objects of analysis. The involvement of the

teacher in the analysis of educational data, communication with teachers in the subject field of the analysis of educational data, changes the position of the teacher from "weak-willed and accusing" to the position of the organizer of new educational methods "above previous barriers".

The origin of reflection can only be understood in a communication relationship (Schedrovitsky, 2019). The development of pedagogical reflection is the main "cross-cutting task", "cross-cutting technology" in organizing professional development programs for teachers and educational leaders: "Pedagogy based on data", "Management of education based on data". The teacher begins to look at the educational situation through the prism of other means. "And then in relation to the past movement, this new thinking performs a reflective function. In fact, there is no reflection, there is a function and this function is associated with a change of means" (Metropolitan schools will be attracted to the development of effective solutions, 2019).

Discussion

What can be ways to educate teachers in a culture of educational data analysis? And do all of them allow the realization of that very "magical" function - the change of pedagogical means and the development of pedagogical reflection?

Based on the analysis of practice, the following methods can be distinguished:

1) regulatory and administrative (the introduction of the "standard of function" in the internal labor regulations, the change of official duties, the introduction of the "Regulations on the intra-school system for assessing the quality of education", the introduction of the "Code of Pedagogical Ethics", etc.);

2) competence-developing (the implementation of continuing education programs for teachers and educational leaders in the field of "Pedagogy based on data", "Management of education on the basis of data");

3) organizational and positional (Fiofanova, 2014) (the organization of communication and exchange of experience in a diverse professional environment, for example: mutual learning of teaching teams);

4) professional and cultural (professional competitions to identify the best teaching practices and their translation into mass practice as a new cultural norm) (Regulation on the competition of cases" Pedagogy based on data ", 2019).

At different stages in the cycle of development of pedagogical reflection: the formation of a new function (new instruments of activity) - the establishment of a new function as a cultural norm in the professional

community - the socialization and translation of a new function as a cultural norm in the professional community; - all of these ways are important.

Let us consider in more detail professional and cultural (professional competitions for the identification of the best pedagogical practices and their translation into mass practice as a new cultural norm).

As part of the implementation of the grant project "Methodology for the analysis of big data in education and its integration into training programs for teachers and heads of educational institutions in the logic" Pedagogy based on data "," Management of education based on data ", we organized the All-Russian case competition" Pedagogy based on on the data. " The competition is held in order to identify and disseminate the best Russian practices on the use of data on education and development of students in the organization of the educational process, improving the quality of educational results based on data analysis.

Contestants are invited to submit pedagogical cases for the contest in one of the substantial areas of analytics of data on education and human development:

a) analysis of data on individual, age, personality, cognitive foundations of personalization of education on the basis of a digital educational platform (analysis of educational motivation, choice of a training profile, self-determination of cognitive interests and their pedagogical accounting in the organization of educational, research and design activities of students with the aim of pedagogical support of individual educational routes);

b) analysis and organization of educational content based on the technology of analyzing data on personal choices and cognitive interests of students; organization of the educational situation in working with digital resources and services for students;

c) analysis of data on the results of intermediate, final certification, solving olympiad problems to predict academic success, Olympiad achievements, analysis of educational results of students to predict decisions on improving the quality of education.

Competition experts evaluate the work submitted to the competition (Cases) according to the following criteria:

- the completeness of the analysis of indicators characterizing data on the education and development of a person and their use in pedagogical practice;

- objectivity of data analysis using information services, a variety of methods for the analysis of educational data and data on human development (in particular: in-memory analytics in the study of "digital tracks" collected in an electronic journal, electronic diary and other logs for subsequent analysis; analytic -statistical methods for the study of intelligent training systems (intelligent tutoring system); methods for analyzing digital services and data analysis of training systems (learning management system), methods for organizing an educator s data to make organizational and pedagogical solutions in education (big data management in education);

- the validity of the problem being solved by the proposed methods for its solution;

- the reasonability of the factors identified on the basis of the analysis of these relationships that determine the quality of education and the quality of the educational results of students.

Based on the results of the case competition, it is planned to publish the Cases portfolio "Analysis of data on human education and development: analytical methods and organizational and pedagogical decisions".

Conclusion

Thus, the introduction of teachers to the culture of analysis of educational data is possible through the following methods:

a) competence-developing - the implementation of continuing education programs for educators and education managers (within the framework of the project, we launched two new continuing education programs in the fields of "Pedagogy based on data", "Management of education based on data");

b) organizational and positional - the organization of mutual learning of pedagogical teams, diverse communication and the exchange of experience in the professional environment (within the framework of the project, we changed the services for organizing the professional development of pedagogical and management teams);

c) professional and cultural - the organization of professional competitions (within the framework of the project, we organized the Case Competition "Pedagogy based on data" to identify the best pedagogical practices and their translation into mass practice as a new cultural norm).

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