DOI https://doi.org/10.30525/2592-8813-2022-1-12

THE STRUCTURAL AND FUNCTIONAL MODEL OF DESIGNING DIGITAL COMPETENCE OF FUTURE ELECTRICAL PROFILE SPECIALISTS

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Abstract. In the publication, the role of the design of the educational process in an agrotechnical institution of higher education is actualized. The author describes the theoretical and methodological aspects of developing the structural and functional model of designing the educational process on the example of digital competence of future specialists in electrotechnical engineering. The composed model generalizes theoretical results of designing the educational process in the form of interconnected components: target; methodological; subjective; objective; procedural; diagnostic-comparative. In particular: the target component consists in designing digital competence of future specialists of electrotechnical profile; the methodological component is implemented through the use of certain methodological approaches (competence, information, system, terminology, modeling); the subjective component unites teachers and students; the objective one is aimed at the components of the educational process; the procedural component determines the stages of the design activity; the diagnostic-comparative component is to determine the criteria, levels and indicators of digital competence of students.

Key words: digital competence, educational process, designing, structural and functional model, design stages, future specialists.

Introduction

Social and economic changes that dominate Ukrainian society nowadays, make new demands on the training of future specialists, including those in the field of electrical engineering. The labor market of the modern information society of the country needs specialists in electrical engineering who are able to make reasonable decisions about the use of computer-aided design (CAD), manufacturing (CAM) and engineering calculations (CAE).

Today, the task of an agricultural institution of higher education is to design a future specialist in electrical engineering, both of professional and digital competencies. This requirement is due to the fact that the full mastering of digital competence by a future specialist will contribute to a deeper solution to the problems of design and operation of electromechanical systems and complexes, i.e. improving the quality of their training.

The importance and necessity of the formation of digital competence of future specialists is emphasized in a number of domestic regulations: the National Strategy of Education Development in Ukraine for 2021-2031 (2020); Law of Ukraine "On Higher Education" (2021); Law of Ukraine "On Education" (2017); the Decree of the President of Ukraine "On the Sustainable Development Goals of Ukraine until 2030" (2019). The establishment of a separate Ministry of Digital Transformation of Ukraine also testifies to the serious intentions of the government (www.kmu.gov.ua/npas/pitannya-ministerstva-cifrovoyi-t180919), whose main task is the formation and implementation of State policy on digitalization, digital economy, digital innovation, digital skills of citizens and the development of the information society.

In view of the mentioned research and scientific works, we noticed that insufficient attention is paid to the design of digital competence of electrical specialists, and this does not contribute fully to the formation of professional competence among educatees of higher institutions under the condi-

tions of digitalization of society.

The objectives of the article. To develop and substantiate the structural and functional model of designing digital competencies of future specialists in the field of electrical engineering.

The methodology of the research

In order to solve the objectives of the study, the following methods were used: structural and functional analysis; modeling; systematization and generalization of the obtained results. This study is closely related to the scientific work on "Development of scientific and information support for sustainable rural development of the western region of Ukraine" (RK № 0108U008826), which is carried out in the NULES of Ukraine "Berezhany Agricultural Institute".

The results of the research

In scientific resources, pedagogical design is considered to be a value-oriented, deeply motivated, highly organized, purposeful activity, in order to pre-develop the basic elements of the pedagogical situation or the whole pedagogical process and change the pedagogical reality (Honcharenko, Sharko 2011, p.24). The term "model" is understood as a mental system that reflects certain properties of the object of study, the principles of its internal organization or functioning (Lodatko 2014, p.126).

Important for our study are the views of J. Stoltenkamp, who argues that the place of models in educational discourse has become more prominent in response to the demand for quality education (Stoltenkamp, 2012). In this context, for the purpose of studying and researching the design model of digital competence, a methodological model of design activities (Kolodiichuk 2009, p.50) and a conceptual model of designing the educational process were pre-developed (Kolodiichuk 2019, p.75).

We are of the opinion that in order to holistically characterize the design and achieve the goal of the study, it is necessary to substantiate the structural and functional model. That is, we imagine the direction of creating the structural and functional model of designing digital competence as the following models: methodical; conceptual; structural and functional.

In the course of the research we identified the components of the pedagogical model of designing digital competence (Fig. 1). In particular: target; methodological; subjective; technological; parametric; diagnostic and comparative.

In determining the basics of such model of designing digital competence in an agricultural institution of higher education, we proceeded from the requirements (personal and socially significant) for a modern specialist in electrical engineering: training a competitive and professionally mobile specialist in the labor market.

The theoretical prerequisite for the model of designing digital competence was the insufficient level of training of the electrical engineering profile graduates; increasing the variability of software and methodological support; disregarding the synergetic development of future activities related to the widespread use of digital technology.

In studying the proposed pedagogical model, we used the approach that involved structural (explanation of each element) and functional (explanation of functional relationships) analysis.

Let us characterize the main components (theoretical constructs) of the model of designing digital competence in an agricultural institution of higher education.

The target component of our model characterizes the goals of the design process. That is, it directs the strategy of designing the educational process through the presentation of the goal. This is confirmed by Buinytska O.P., who notes that the design of the model should begin with the definition of the purpose (Buinytska 2019, p.271).

The general purpose of the research is to design the digital competence of future specialists in electrical engineering in an agricultural institution of higher education. It is important to focus on creating such design system that would take into account the positive aspects of the existing system of training future electrical professionals in the agricultural institution of higher education, the objectives of the study and the social demand.

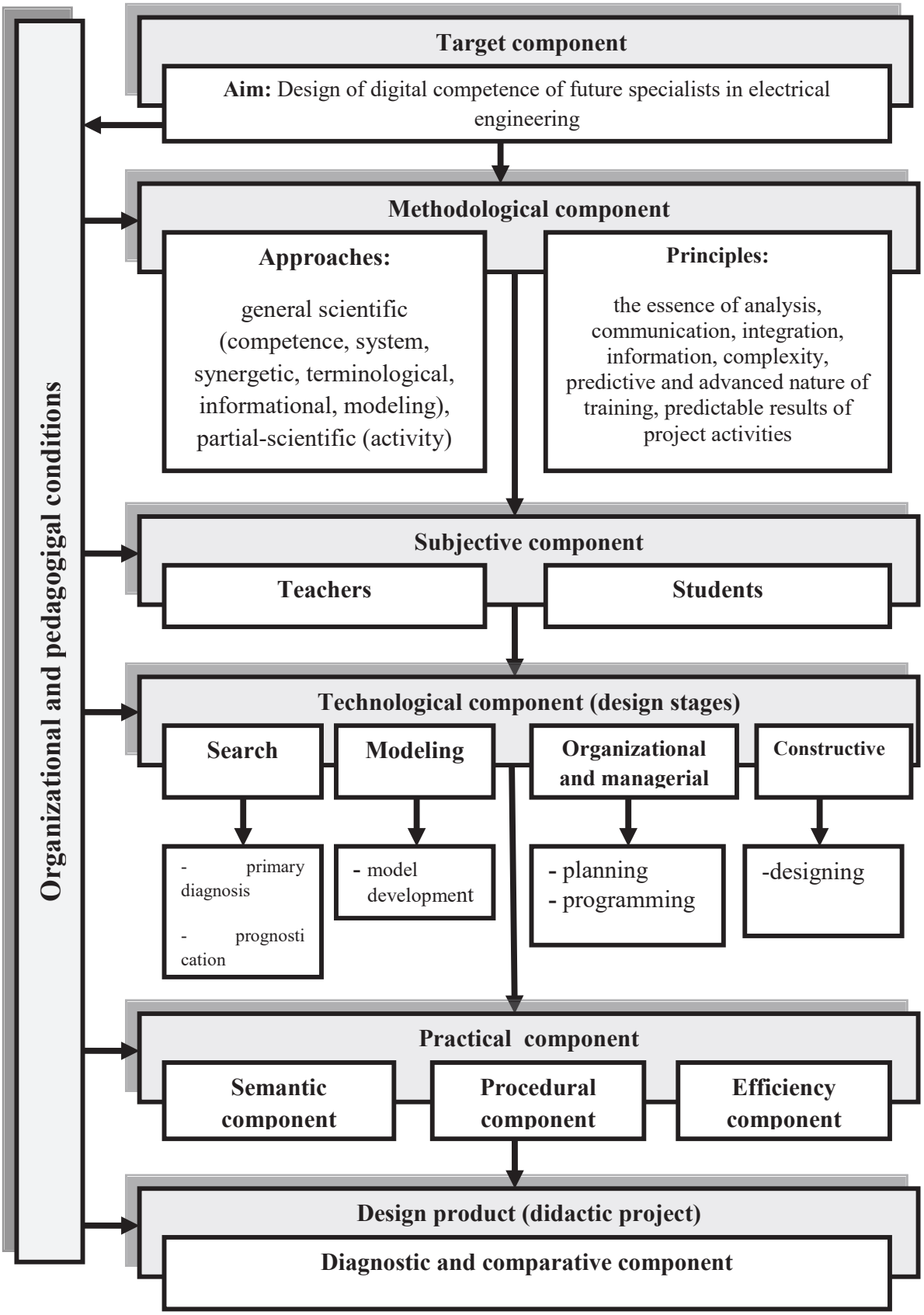

Fig. 1. Structural and functional model of designing digital competence of future specialists in electrical engineering.

That is, the target component is determined by the design and is the need to improve the training of future specialists in electrical engineering.

Pedagogical research should be considered from the standpoint of methodology (Kozlovskyi 2018, p.9). At the same time, the success of designing the educational process of training future specialists in electrical engineering depends on the correctly chosen methodological approaches (methodological component) of the study. In particular, in solving the problem of designing digital competence in an agricultural institution of higher education, the methodological principles are defined in accordance with the following levels (Kolodiichuk 2019, p.44):

- philosophical level, represented by the general principles of cognition (communication and development), the laws of dialectics and the categorical apparatus of science;
- general scientific methodology, defined in the research by competence, information, system, terminological approaches and modeling;
- specific scientific methodology, represented by a synergetic approach and a significant arsenal of methods, etc.;
- partial methodology provides a method of designing individual technical disciplines.

Structuring the system of general scientific approaches with the analysis of the design of the educational process in agricultural institutions of higher education , we single out:

- *competency approach,* aimed at designing the digital competence of future specialists based on students' performance;
- *information approach,* aimed at the formation of general competencies of a future specialist in electrical engineering;
- *modeling,* aimed at students' mastering the special competencies of designing virtual tools, which model a variety of technological processes in agro-industrial production;
- *terminological approach,* aimed at structuring the categorical apparatus of designing the educational process of training future specialists in electrical engineering;
- *systematic approach,* aimed at developing the model of the system of designing digital competence of future electrical specialists.

In substantiating the approaches to the theoretical and methodological foundations of designing digital competence, special principles were followed, which include:

- *prognostic and advanced nature of training future specialists in technical specialties;*
- *expected results of project activities;*
- *professional orientation.*

In the course of substantiating the study, we relied on the concept of identifying the main link (Babanskii 1982). At the same time, the important technique that made it possible to penetrate into the holistic properties of the model was the identification of such a component that would reflect the specifics of the object under consideration. In our case, the subjective component is identified, which plays a key role and determines the subject of interaction between a teacher and a student - the designing of digital competence of the future specialist.

Parametric block**.** This component is represented by the main directions of design actions in the educational process. Thus, the effective component of the parametric block projects the result of training future electrotechnical specialists. In particular, the formation of digital competencies through modeling professional activities, independent work of students and stepwise assessment of knowledge.

The modeling of professional activity revealed the main means of implementing the integration of the content of disciplines through: modeling of production situations (All-Ukrainian Olympiads); modeling of technological processes and modeling of systems (graduate bachelor's and master's theses).

This gradual formation of competencies provided for the gradual development of cognitive activity of future specialists in electrical engineering on a level basis.

The technological component of the model is generally implemented in the design concept and provides stages of design activities based on decision-making. The study proposes an algorithm for design activity: the search stage consists in the implementation of primary diagnostics and prediction of the results of the educational process; modeling, provides for the development of a prognostic model, the creation of a general idea of the design results; organizational and managerial (planning, programming) involves the choice of parameters of the educational process and their structuring; designing specifies the planning and programming stages. In the developed model, the stages of designing digital competence are highlighted and are repetitive.

In order to obtain and achieve the projected result (development of a didactic project), the indicated stages of design activities were observed.

The readiness of the didactic project of the corresponding documented form for implementation in the educational process of an agricultural institution occurs by means of an expert survey on the basis of fuzzy logic.

The final component of the model is diagnostic-comparative. Such block encloses the formation of the future specialist in the conditions of the process of prediction and forecasting the results of pedagogical activity.

This component directly diagnoses the results of training of future specialists in electrical engineering and assesses the formation of students' digital knowledge and skills, attitudes, values, orientations in accordance with the social demand.

The diagnostic-comparative component of the model covers the establishment of levels, indicators and criteria of digital competencies. It provides the information about the actual results in the educational process of a future specialist.

The final block of the model is based on the mechanism for diagnosing the students' mastering of the content of education, in particular:

- a set of assessment materials based on traditional and competency-oriented means of control (integrative tasks);

- computer diagnostics of mastering the content of education, which is focused on the quick assessment of the degree of achievement of goals - the requirements for the readiness of students and graduates;

The developed model is impossible without the implementation of certain conditions. Substantiation of the effectiveness of digital competence design involves the definition of such pedagogical conditions, the implementation of which ensures successful design activities. The results of the theoretical study made it possible to determine the organizational and pedagogical conditions for designing the educational process of training future specialists in electrical engineering (Kolodiichuk 2020, p.319):

1) formation of motivational readiness of teachers of agrotechnical institutions of higher education (combination of motives and goals) for designing the educational process;

2) designing the system of electrotechnical knowledge of students taking into account the digital component in the conditions of the agricultural sector of the economy;

3) designing the system of skills via modern information tools, which is based on the combination of traditional and innovative forms of learning (modular learning system, project-based learning, distance learning, etc.);

4) gradual formation of digital competence of the future specialist of electrotechnical profile on the basis of the competence approach.

Thus, the model of designing digital competence of future specialists in electrical engineering in an agricultural institution of higher education is a structural and functional set of components, with the aim of developing didactic projects.

The developed model of designing digital competence is aimed at the complex construction of components of the educational process and assumes that any changes in the content, form and actions

of any component of the pedagogical model were accompanied by appropriate functional and semantic restructuring of the rest of the components of the designed pedagogical model.

That is, the developed model makes it possible to holistically predict the course of designing the educational process, taking into account the synergetic characteristics of improving the quality of the educational process.

We believe that the union of the goals and the result of training is realized by the proposed structural and functional model. This model logically fits into the leading educational concepts, primarily, the "Sustainable Development Goals of Ukraine until 2030". Indeed, in the developed model, the projection of the concept of the organization of the educational process is clearly traced. In particular, the pedagogical model is focused on the formation of digital competence of students, which is one of the components of the professional competencies of graduates in an agricultural institution of higher education.

During the study of scientific literature and our own observations, it was found that the structural and functional model of designing digital competence is built in stages: a conceptual model of designing the educational process (based on the methodological model) was developed; the target component of the model was determined (including the goal of the design - the result of the formation of digital competence), the designers were decided on; design parameters (components of the educational process) were set; the technological components of the design of the educational process were determined, namely the stages of design activities: search, modeling, organizational and managerial, and design; the final stage was aimed at the implementation of the developed didactic project in the educational process of an agricultural institution of higher education and provided for the diagnosis of the formation of digital competence with the help of criteria, levels and indicators.

Conclusions and prospects for further research

Thus, the built structural and functional model reflects the design of digital competence of future specialists in electrical specialties in an agricultural institution of higher education. This model summarizes the theoretical results of the design of the educational process in the form of components: target, methodological, subjective, procedural, parametric, as well as diagnostic and comparative components.

That is, the developed model defines the theoretical and methodological foundation for the design of the educational process, which provides a perfect understanding of the structure, methods and means of building appropriate educational activities in order to develop didactic projects that create conditions for successful training of future technical specialists in agricultural institutions of higher education.

To the next stages of scientific research, we attribute the introduction of the structural and functional model of designing digital competence of future specialists in electrical engineering into the educational process of agricultural institutions of higher education.

References:

1. Honcharenko T., Sharko V. (2011) Tekhnologhiji proektuvannja navchaljnogho procesu z fizyky ta pidghotovka vchytelja do jogho realizaciji [Technologies for designing the educational process in physics and preparing teachers for its implementation]. *Physics and astronomy at school*, no. 8, pp. 23–27.
2. Lodatko Y. A. (2014) Tipologiya pedagogicheskikh modeley [Typology of pedagogical models]. *Vektor nauki TGU* [TSU science vector] (electronic jornal), no. 1(16), pp. 126–128. Retricved from: https://journal.tltsu.ru/rus/index.php/VNSPP/article/view/2038 (accessed 26 January 2021).
3. Stoltenkamp J. (2012) Show-casing indicators to a changing organizational culture through the development of an integrated elearning model: indications of a changing organisational culture at the university of the Western Cape (UWC), *Problems of Education in the 21st Century,*

vol. 39(1), pp. 145–158. Retricved from: https://journals.indexcopernicus.com/search/article?articleId=1928650 (accessed 28 January 2021).
4. Kolodiichuk L. S. (2009) Etapy pedaghoghichnogho proektuvannja navchaljnogho procesu [Stages of pedagogical design of educational process]. *Youth and the market: scientific and pedagogical journal*, vol. 6(53), pp. 48–50.
5. Kolodiichuk L. S. (2019) Osnovni aspekty koncepciji proektuvannja osvitnjogho procesu pidghotovky majbutnikh fakhivciv elektrotekhnichnogho profilju [The main aspects of the concept of designing the educational process of training future specialists in electrical engineering]. *Innovative pedagogy,* vol. 11, pp.73–76.
6. Buinytska O.P. (2019) Strukturno-funkcionaljna modelj informacijno-osvitnjogho seredovyshha universytetu [Structural and functional model of the information and educational environment of the university]. *Informacijni tekhnologhiji ta zasoby navchannja* [Information technologies and teaching aids] (electronic jornal), vol. 63, no. 1, pp. 268–278. Retricved from: https://journal.iitta.gov.ua/index.php/itlt/issue/view/98 (accessed 26 January 2021).
7. Kozlovskyi Y. M. (2018) *Metodologhija pedaghoghichnogho doslidzhennja* [Methodology of pedagogical research]. Lviv: VLP. (in Ukrainian).
8. Kolodiichuk L. S. (2019) Metodologhichni pidkhody do proektuvannja osvitnjogho procesu pidghotovky majbutnikh fakhivciv elektrotekhnichnogho profilju [Methodological approaches to designing the educational process of training future specialists in electrical engineering]. *Pedagogical sciences*, vol. LXXXVI, pp. 42–45.
9. Babanskii Y. K. (1982) Problemy povysheniya effektivnosti pedagogicheskikh issledovaniy [Problems of increasing the effectiveness of pedagogical research]. Moscow: Pedagogy. (in Russian).
10. Kolodiichuk L. (2020) The conditions of designing the educational process of future electrical profile specialists training. *Vector of modern pedagogical science in Ukraine and EU countries*. *Collective monograph*. Riga: Izdevnieciba Baltija Publishing, pp. 305–320.