

FORMATION OF PROFESSIONAL COMPETENCE OF FUTURE AGRICULTURAL ENGINEERING SPECIALISTS STUDYING DISCIPLINE “MAINTENANCE OF MACHINERY AND EQUIPMENT”

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Abstract. The article discusses the development problem of the professional competence of the future agricultural engineering specialists when studying the discipline “Maintenance of Machinery and Equipment.” The proposed model is based on the requirements of a social order of the society and stakeholders of the agricultural industry for highly qualified specialists who stand out by professional responsibility and readiness to efficiently and creatively perform their professional duties. The input element of our research is the goal of professional training at educational institutions of the future agricultural engineering specialists for the maintenance of machinery and equipment in accordance with the current and future needs of economic sectors and the state in the context of globalization in accordance with international requirements of technical regulation. The basis of the research are the theoretical (comparative analysis of scientific, methodological and pedagogical literature) and the empirical (observation, analysis and generalization of pedagogical learning experience) methods. There are determined and theoretically substantiated the psychological and pedagogical conditions for the implementation of the developed models in the process of studying these disciplines. The efficiency of the developed logical models, and their impact upon the components of professional competence, carried out through the use of approaches to the acquisition of scientific knowledge, the use of integrative learning technologies, as well as increasing cognitive activity, motivates students to study the discipline of maintenance of machines and equipment.

Key words: competence, professional orientation, professional training, specialist, agricultural engineering.

Introduction

Education plays several important roles in society. It not only imparts knowledge and skills but also promotes the development of critical thinking, creativity and analytical skills. The problem of the shortage of specialists in the field of agricultural production is becoming urgent because the practical training of the future agricultural engineers does not meet the requirements of the modern labour market. This is because of the low level of professional training and uncertainty in the future specialists, in demonstrating their professional skills, as well as rapid technological changes, modernization and improvement of agricultural production and agricultural machinery.

One of the key aspects of success of the future agricultural engineers is an ability to make informed and efficient decisions, based on the knowledge, skills and abilities that they acquire during the training process. Thus, solving the problem requires creation of pedagogical conditions for the formation of professional competence of the students. This determines the topicality of the search of technologies for the formation of professional competence in training specialists in the agricultural and technical industry.

Professional competence determines the level of professionalism of an individual, and its achievements occur through the acquisition of necessary competencies, which is the goal of professional training of specialists. By competence we mean a set of interdependent qualities of a person (knowledge, abilities, skills, methods of activity) necessary for high-quality productive activity. This is a system of scientific knowledge, intellectual and practical abilities and skills, personal qualities and formations, which, with sufficient motivation and a high level of professionalism, ensures self-realization, self-preservation and self-improvement of the individual in the process of professional activity.

The proposed methodology for the formation of professional competence of the future agricultural engineers in the process of studying special disciplines is based on the methodological foundations of competence-based and personal-activity approaches and is understood as the scientific basis for the result and process of professional training of the future specialists. It is expressed by systemic quality – competence, which ensures the ability of agricultural engineers to perform efficient professional activities. The methodology allows to define, specify and correlate the requirements of standards and

elements of professional competence: professional skills, a set of acquired professional knowledge, motives and reflection of professional activity that is necessary for successful mastery of a specialty.

The problem of professional competence has been studied by many philosophers, teachers, and psychologists. The issues of formation and development of professional competence are considered in the works by: V.A. Adolf, T.G. Braje, E.F. Zeera, I.A. Zimnyaya, N.V. Kuzmina, M.I. Lukyanova, A.K. Markova, A.M. Novikova, G.S. Trofimova, G. Bernhard, W. Bloom, H. Markus, R. Sterner and others.

Of greatest interest are the works that investigated the problems of professional competence in the system of training specialists in the agricultural and technical industry, where the main attention was paid to interdisciplinary connections between physics and technical disciplines: I. Beloev [1], O. Bulgakova [2], S. Nikolaenko [3; 4], L. Zbaravskaya [5].

Much attention has been paid to a certain problem in foreign publications [6; 7], Guerrero-Roldan A.-E. and Noguera I. [8], Herrmann A., Hirschi A. and Baruch Y. [9], Nicolopoulou A. and Cole M. [10], Nind M. and Lewthwaite S. [11]. In addition, it should be especially emphasized that successful formation of deep professional competence among the future agricultural engineers, especially, when studying such issues as functioning, operation and maintenance of agricultural machinery and equipment, will be most efficient when the issues of simulation of the complex dynamic systems are introduced into the learning process, graphic interpretation of the processes that are carried out, etc. Without involving into the learning process of examples taken from fundamental scientific articles, the acquisition of relevant competencies by the future engineers will not be efficient enough.

A necessary condition for the socio-economic development of any country is investment in the education of the population. In this context globalization of education contributes to the personal and professional development of specialists, involved in the development and implementation of the new engineering technologies [12]. The latter is possible when they acquire a high level of professional competence. One of the components of professional competence is information and communication competence the development of which determines the ability of the future specialists in agricultural engineering to efficiently interact in the agricultural environment with their colleagues, management, as well as within the entire system of agricultural institutions, which is especially important for the specialists in agricultural engineering who interact with a large number of people [13].

In the course of investigation Harunasari S. and Halim N. [14] note that a high quality level of training is achieved with a more rational organization of the educational process, with full orientation of the content and forms of professional training to the modern requirements of the specialty and the real conditions of practical activity.

Considering that the educational materials do not adequately focus on studying the efficiency of the methods of developing professional competence and the ever-increasing demands of social practice for competent specialists, it is important to conduct special research on this topic. Therefore, the main goal of our research is theoretical justification and development of a methodology for the formation of professionally oriented skills of the future agricultural engineers when studying the discipline "Maintenance of Machinery and Equipment."

Materials and methods

To solve the problems and achieve the goal of this investigation, a complex of theoretical and empirical methods of scientific research was applied:

- theoretical (analysis, synthesis, comparison, simulation, generalization) for studying the scientific literature and determination of the conceptual foundations of the research, for substantiation and clarification of the essence of the organizational and pedagogical conditions and development of a model for the formation of professional competence of the agricultural engineers;
- empirical (a questionnaire, conversation, direct and indirect scientific observation, a method of expert assessments, self-assessment) to determine the levels of development of professional competence of the agricultural engineers;
- a pedagogical experiment was conducted to test the efficiency of the organizational and pedagogical conditions for the formation of professional competence of agricultural engineers;

- methods of mathematical statistics are used for quantitative and qualitative processing of data, obtained as a result of a pedagogical experiment, displaying these data in graphical forms and tables.

Taking into account the different approaches of scientists to the problem of development of professional competence, we have identified the leading organizational and pedagogical conditions for the formation of professional competence of the future agricultural engineers in professional training (Fig. 1).

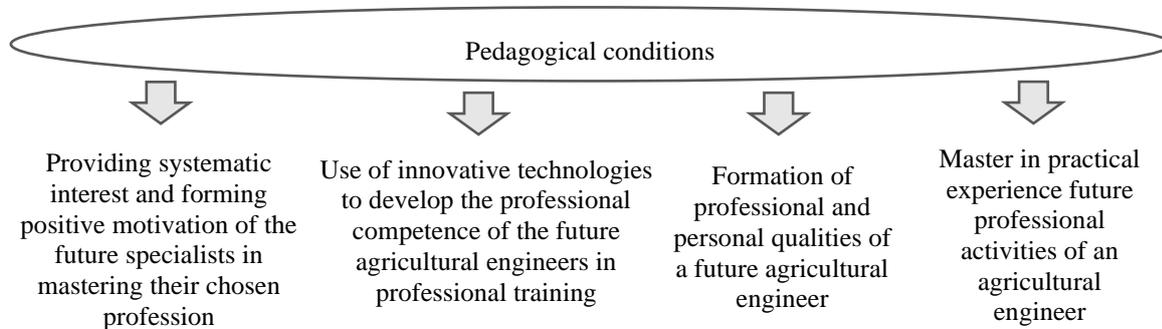


Fig. 1. Pedagogical conditions for formation of professional competence of the future agricultural engineers in professional training

The main factors contributing to the formation of positive motivation when studying the discipline “Maintenance of Machinery and Equipment” for mastering the future profession include:

1. Ensuring systematic interest and formation of positive motivation for the future specialists in mastering their chosen profession:
 - understanding the significance and application of knowledge. If students understand how their learning efforts contribute to their future careers and how they can use what they learn in real life, it can greatly increase their motivation;
 - practical orientation of training. Interactive and hands-on learning methods that allow students to apply their acquired knowledge in practical situations can increase their interest and motivation. Creation of interesting and realistic tasks. Tasks and projects that arouse the students’ interest and real challenges, and increase their motivation to succeed in their studies;
 - use of innovative technologies;
 - use of contemporary technologies and interactive teaching methods makes the learning process for the students more interesting and attractive.
2. Development of a subject content in the discipline “Maintenance of Machinery and Equipment” for professional training of the future agricultural engineers.

Introduction of this organizational and pedagogical condition should take into account the main aspects of the maintenance of agricultural machinery and equipment. For successful operation of this condition, it is necessary to develop and implement thorough interdisciplinary and multidisciplinary theoretical training, as well as to organize practical training on the basis of various institutions with the involvement of the leading industry specialists. Below there are provided a few key elements for this implementation:

- development of joint modules in various disciplines (e.g. agricultural machinery, physics, machine parts, fuels and lubricants, etc.) to create a holistic approach to agricultural engineering;
- a project-oriented approach. Implementation of design tasks that require combined application of knowledge from different disciplines;
- interdisciplinary seminars and lectures. Organization of joint events where the teachers from different disciplines present integrated approaches and interaction of subjects. Organization of conferences and seminars where experts in the field can share their experience and new developments. This approach allows to create a comprehensive training program for agricultural

engineers that takes into account modern industry requirements and provides graduates with the necessary knowledge and skills for a successful career in the agricultural sector;

- practical training. Providing access of the higher education applicants to modern laboratories with specialized equipment to perform practical tasks. Conducting training practices and master classes directly at agricultural enterprises to gain real experience. To implement this pedagogical condition, we invite well-known specialists from the agro-industrial sector to the welcoming lectures and master classes in order to exchange experiences.

3. Formation of professional and personal qualities of a future agricultural engineer.

The discipline “Maintenance of Machinery and Equipment” in agricultural engineering not only provides students with the necessary technical skills for efficient management and maintenance of the agricultural equipment but also contributes to the formation of professional and personal qualities. Here are a few aspects that can be taken into account when developing these qualities:

- development of deep technical knowledge in the field of modern agricultural machinery and equipment;
- training to diagnose efficiently breakdowns and identify problems in the equipment operation;
- studying practical skills in regulation, maintenance and repair of agricultural machinery;
- formation of these qualities will help the students not only to master effectively the technical aspects of agricultural engineering but will create the basis for the development in their personal and professional lives. Mastering skills of work with the automated control and monitoring systems.

4. Acquisition of practical experience of the future professional activities of an agricultural engineer.

The discipline “Maintenance of Machinery and Equipment” is the key to mastering the practical experience of a future agricultural engineer. It is important to create a program that will not only provide students with theoretical knowledge but also allow them to gain real-life practical experience. Here are several directions for organizing the practical component of the discipline:

- use of specialized equipment and simulators to teach the students the basic maintenance skills;
- organization of internships for the students at various agricultural enterprises where they will be able to apply the acquired knowledge in practice;
- development of projects, including technical maintenance and repair of agricultural machinery;
- conducting simulations of emergency situations for training students to solve unforeseen problems;
- organization of the students’ visits to modern agricultural enterprises and service centres for acquaintance with modern technologies and methods of the service technology;
- cooperation with agricultural enterprises on development and implementation of real projects on technical maintenance;
- organization of training events on the field for training the students under real conditions.

Such an approach allows the students not only to obtain technical knowledge but also to apply it in practice, to develop in them the skills of independence, efficiency and adaptability which are recognized as the key in the professional activity of an agricultural engineer.

Organization of practical experience in the discipline “Maintenance of Machinery and Equipment” will contribute to training the students for the challenges of the modern agricultural engineering sector and will prepare them for the work in the field of technical maintenance of the agricultural machinery. Such a complex approach to the implementation of pedagogical conditions will help create favourable conditions for the formation of professional competence of the future agricultural engineers, which takes into account the needs of the modern labour market and promotes their successful adaptation in the professional sphere.

In order to determine the priority of orientation of the educational process to the development of professional skills and the skills of applicants in the process of studying the discipline “Maintenance of Machinery and Equipment”, a pedagogical experiment was conducted. The experiment was carried out in four stages: the preparatory, establishing, forming and final. The basis for the experimental study was the institution of higher educational “Podillia state university”. In total, 190 students, teachers and

specialists from the agricultural and technical industry participated in the experiment at different stages of the study. At the preparatory stage of the pedagogical experiment, analysis of the educational and qualification characteristics, the educational and professional program and the educational process plan for training graduates of specialty 208 “Agroengineering” studying the discipline “Maintenance of Machinery and Equipment” was performed. Classes in this discipline were conducted using traditional forms and methods, using morally and physically outdated samples of agricultural machinery. The result of this was the students’ fragmented knowledge about their future profession, a decrease in internal motivation for learning, and inefficient application of the skills for autonomous activity. At the establishing stage of the pedagogical experiment, the state of formation of the professional competence of future agricultural engineers for professional activities in the process of studying the discipline “Maintenance of Machinery and Equipment” was revealed; a qualitative and quantitative analysis of the results obtained was carried out; the organizational and pedagogical conditions for the formation of professional competence of future agricultural engineers for professional activities have been determined. At the ascertaining stage of the pedagogical experiment there was revealed a condition of formation of the professional competence of the future agricultural engineers for professional activities in the process of studying the discipline “Maintenance of Machinery and Equipment”; a qualitative and quantitative analysis of the results obtained performed, the organizational and pedagogical conditions for the formation of professional competence of the future agricultural engineers for professional activities have been determined. The results of the establishing stage of the experiment, which showed the lack of awareness of future agricultural engineers of the peculiarities of professional activity and the low and basic levels of professional competence in this area among the vast majority of respondents, determined the third stage of the pedagogical experiment. During the formation stage of the experiment, we reproduced the proposed organizational and pedagogical conditions for efficient formation of professional competence of the future agricultural engineers; educational and methodological support for the formation of professional competence of the future specialists for professional activities in the process of studying the discipline “Maintenance of Machinery and Equipment” has been developed, tested and introduced into the educational process; a repeated diagnostic study of respondents from the control (reference) and the experimental groups was conducted. The formation stage of the experiment took place under the conditions of a real educational process on the basis of the higher education institution “Podillia state university” with 190 students studying in specialty 208 “Agroengineering”. Two groups were formed: an experimental study group ($n = 95$) and a control (reference) group ($n = 95$). The groups studied according to the same programs but in the experimental group all the organizational and pedagogical conditions formed in the study were used.

Results and discussion

During the formation experiment of the study, based on the introduction of innovative technologies when studying the course of the discipline “Maintenance of Machinery and Equipment”, the data of each experimental event was recorded according to the corresponding system for assessing the level of formation of the professional competence of the future agricultural engineers. Recording the data about the results of the control activities and the results of questionnaires made it possible to determine the level of development of professional competence in compliance with the principles of objective assessment. Visual results of the development of professional competence of the future agricultural engineers are presented in Figure 2.

During the experimental research, we checked the formation of professional competence of the students of specialty 208 “Agroengineering”. Students of the higher education institution “Podillia state university” participated in the experiment.

In the process of conducting and attending all forms of classes in special disciplines studied by future agricultural engineers, observing the activity of students and analyzing the effectiveness of their educational activities, we made the following conclusions:

- the vast majority of classes are conducted using the traditional methods of lecturing, interviewing students and performing a standard set of actions during practical classes;
- inclusion by teachers in the educational process of training future agricultural engineers of new pedagogical technologies, such as role-playing, brainstorming, excursion, project method, etc. has an episodic nature and is observed, for the most part, during open classes;

- a survey of teachers on the subject of their readiness to implement pedagogical innovations in the process of professional training of students showed the interest of teachers in progressive methods, but, at the same time, demonstrated the unwillingness of teachers to use them in the educational process;
- the analysis of feedback from stakeholders about graduates shows that their professional skills are poorly formed and the need for additional training at the workplace, which is due to the disconnection of training programs from real challenges;
- the survey of experts in the relevant field allowed us to conclude that they are interested in close cooperation with the graduate departments of higher educational institutions for the purpose of implementing contextual learning, but, at the same time, there are certain difficulties of an organizational nature;
- the majority of students did not show initiative and activity in the process of conducting traditional classes, and the results of independent activity were determined, for the most part, during the performance of individual tasks and coursework;
- interviews with students revealed their lack of confidence in their capabilities and willingness to reproduce and use professional knowledge in practice.

Thus, the results of the conducted research allow us to draw a conclusion about the correctness of the approach that was used when defining the category “professional competence of agricultural engineers”, researching and determining the organizational and pedagogical conditions necessary for the formation of professional competence of future specialists in the agricultural sector, and put forward the hypothesis that the implementation of these conditions in the educational process will increase the effectiveness of training and bring its results closer to the level set by the reference trajectory of training.

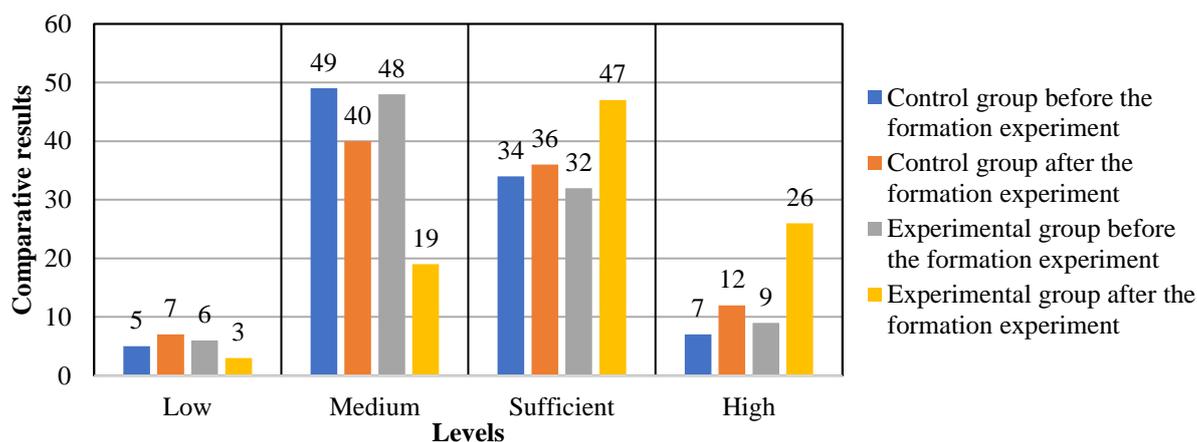


Fig. 2. Comparative results of the development of professional competence of the agricultural engineers

Analysis of the obtained results confirmed the efficiency of implementation of the proposed methodology for the development of the professional competence of the future agricultural engineers in the process of studying the discipline “Maintenance of Machinery and Equipment”, the system-forming factor of which is determined by organizational and pedagogical conditions. The efficiency of applying organizational and pedagogical requirements within the framework of the proposed model for the formation of professional competence of future agricultural engineers has been experimentally proven, which is reflected in the positive dynamics of the levels of the professional competence development. The results of the experiment showed an increase in the number of students with indicators of a high (+17 students) and sufficient level (+15 students) in the experimental group after the experiment and, accordingly, a decrease in the number of students at medium and low levels.

Attention to the problem of development of professional competence of the future specialists is given in a large number of publications. The main emphasis of this study is laid on an integrated approach to the formation of professional competence, which includes not only the transfer of knowledge but also the development of practical skills, abilities and professional self-reflection among the students.

The methodology, proposed in this article for developing of professional competence of the future agricultural engineers in the process of studying the discipline “Maintenance of Machinery and Equipment”, with a certain system-forming factor in the form of organizational and pedagogical conditions, differs from the existing approaches [6-11].

The conducted research pays special attention to the organizational and pedagogical aspects of training. This includes the creation of special conditions, such as laboratory workshops, field work, the use of modern educational technologies, etc., which contribute to more efficient learning of the material and development of professional skills among the students. These innovations make training more accessible, efficient and interesting for the agricultural engineering students, and also prepare them to work with the modern agricultural equipment and technologies.

Conclusions

1. The results of the pedagogical experiment make it possible to assert that the implementation of each of these pedagogical conditions positively contributes to ensuring efficient formation of professional competence of the future agricultural engineers in professional training with the subsequent identification of the characteristics of their educational activities.
2. Pedagogical conditions are the key parameter in determining whether the agricultural engineers achieve a high level of professional competence.
3. The effectiveness of the application of organizational and pedagogical requirements within the framework of the proposed model of formation of professional competence of future agricultural engineers has been experimentally proven, which is reflected in the positive dynamics of the levels of professional competence formation.
4. The results of the experiment showed an increase in the number of students with high and sufficient level indicators in the experimental group by 16% after the experiment, and a corresponding decrease in the number of students at medium and low levels.
5. Correct organization and application of the proposed pedagogical conditions in professional training, efficient interaction of all participants in the educational process to facilitate adaptation to accelerated technological developments, modernization of agro-industrial production and agricultural machinery and the intensification of their practical training are crucial for the formation of a competitive specialist in the agro-industrial sector.

Author contributions

Conceptualization, O.B.; methodology, O.B. and I.S.; software, L.Z.; validation, O.B. and S.H.; formal analysis, I.D. and O.B.; investigation, O.B., I.S., S.H. and L.Z.; data curation, I.D., O.B. and I.S.; writing – original draft preparation, A.R.; writing – review and editing, A.R. and I.D.; visualization, A.R., I.D.; project administration, I.D.; funding acquisition, A.R. All authors have read and agreed to the published version of the manuscript.

References

- [1] Beloev I., Vasileva V., Shynkaruk V., Bulgakova O., Bondar M., Zbaravska L., Slobodian S. Modernization of the content of the lecture course in physics for training future agricultural engineers. *Strategies for Policy in Science and Education*. Vol. 31, Number 1, 2023. pp. 73-84.
- [2] Bulgakova O., Zbaravska L., Dukulis I., Rucins A. Content of professionally oriented training in course of physics for students of agricultural engineering specialties. *Engineering for Rural Development*. Vol. 22, 2023. pp. 661-666. DOI: 10.22616/ERDev.2023.22.TF134
- [3] Nikolaenko S., Bulgakova O., Vasileva V., Dukulis I., Zbaravska L. Study in possibilities of professional orientation in training of specialists in agrarian and technical universities. *Engineering for Rural Development*, Vol. 20, 2021. pp. 212–219. DOI: 10.22616/ERDev.2021.20.TF045
- [4] Nikolaenko S., Ivanyshyn V., Shynkaruk V., Bulgakova O., Zbaravska L., Vasileva V., Dukulis, I. Integration-lifelong educational space in formation of competent agricultural engineer. *Engineering for Rural Development*. Vol. 21, 2022. pp. 638-644. DOI: 10.22616/ERDev.2022.21.TF203
- [5] Zbaravska L., Chaikovska O., Semenishena R., Duhanets V. Interdisciplinary approach to teaching physics to students majoring in agrarian engineering and agronomy. *Independent journal of management & production*. Vol. 10(7), 2019. pp. 645-657. DOI: 10.14807/ijmp.v10i7.912

- [6] College Grad LLC. Agricultural Engineers. 2021. [online] [04.03.2024] Available at: <https://collegegrad.com/careers/agricultural-engineers>
- [7] Environmental Science.org. What is an Agricultural Engineer? 2021. [online] [04.03.2024] Available at: <https://www.environmentalscience.org/career/agricultural-engineer>
- [8] Guerrero-Roldan A.-E., Noguera I. A model for aligning assessment with competences and learning activities in online courses. *The Internet and Higher Education*. Vol. 38, 2018. pp. 36-46. DOI: 10.1016/j.iheduc.2018.04.005
- [9] Herrmann A., Hirschi A., Baruch Y. The protean career orientation as predictor of career outcomes: Evaluation of incremental validity and mediation effects. *Journal of Vocational Behavior*. Vol. 88, 2015. pp. 205-214. DOI: 10.1016/j.jvb.2015.03.008
- [10] Nicolopoulou A., Cole M., Design experimentation as a theoretical and empirical tool for developmental pedagogical research. *Pedagogies: An International Journal*, Vol. 5, 2009. pp. 61-71. DOI: 10.1080/15544800903406316
- [11] Nind M., Lewthwaite S. A conceptual-empirical typology of social science research methods pedagogy. *Research Papers in Education*, Vol. 35, 2020. pp. 467-487. DOI: 10.1080/02671522.2019.1601756
- [12] Kanat-Maymon Y., Elimelech M., Roth G. Work motivations as antecedents and outcomes of leadership: Integrating self-determination theory and the full range leadership theory. *European Management Journal*. Vol. 38(4), 2020. pp. 555-564. DOI: 10.1016/j.emj.2020.01.003
- [13] Kara S.I. An improvement of process of organization of pedagogical practice is priority condition of forming of professional competence of future teachers the basics of health. *Pedagogics, psychology, medical-biological problems of physical training and sports*. Vol. 17(11), 2013. pp. 28-31. DOI: 10.6084/m9.figshare.815870
- [14] Harunasari S.Y., Halim N. Digital Backchannel: Promoting Students' Engagement in EFL Large Class. *International Journal of Emerging Technologies in Learning (IJET)*. Vol. 14 (07), 2019. pp. 163-178. DOI: 10.3991/ijet.v14i07.9128