INTEGRATION-LIFELONG EDUCATIONAL SPACE IN FORMATION OF COMPETENT AGRICULTURAL ENGINEER

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Abstract. The technology of the competency-based approach requires fundamental changes in the organization, content and methodology of the educational process and a shift of emphasis in theoretical training to theoretical and applied, professionally oriented training. This particularly applies to the fundamental disciplines, in particular physics, as the most universal basic discipline. The purpose of this study is to introduce into the educational process of integration-lifelong educational space in engineering education, aimed at the formation and development of different levels and types of professional competencies. The purpose of the research is to study the organization of an integration-lifelong educational space in the engineering education, aimed at the formation and development of various levels and types of professional competencies. A universal methodology for the integration-lifelong organization of the students' educational activities has been developed. The results of the pedagogical experiment showed an increase in the absolute indicator of the student progress by 9%, which indicates the efficiency of the proposed methodology. There is revealed the influence of the students' specially organized professionally-oriented activity in physics upon the motivation of learning and professional orientation. In addition, motivation to study physics increased by 7%, professional orientation by 11%. Increase in the students' levels of educational achievements, the growth of levels of motivation and professional orientation testify to the efficiency and pedagogical expediency of the proposed methodological principles of the integration-lifelong organization of the students' educational activities.

Key words: educational space, competence, professionalism, engineer, physics.

Introduction

The modern world trends in reshaping the educational space contribute to the growth in demand for relevant competence. However, insufficient application of the integration principle in higher education leads to the fact that "many young people perceive technology only in terms of its products: computers, cars, mobile phones, genetically modified fruits of plants, etc. They do not see technology in terms of the knowledge and processes that create these products. Education does not sufficiently generate interest among the young people in how the world is technologically structured, what are the potential and actual consequences of technology for the environment and individual development of the individual on a local and global scale" [1].

In recent years the problems of integration-lifelong education have become one of the most studied in the world pedagogy of higher engineering education. The works by such scientists as B. Korotyaev, V. Kurilo, V. Tretyachenko and others are devoted to the consideration of the educational space [2]. According to L. Shershnev, the educational space of an educational institution is multidimensional. He includes the habitat, the environment of educational support and the development of a certain production process, and other indicators. I. Bendera, V. Duganets and others [3-7] consider the concept of educational space as a continuous unity of many individual forms of development of the student's educational opportunities, the inevitable receipt of the meaning of the information systems. The optimal management of the educational space provides such results as purposefulness, speed, efficiency, self-learning, based on a clear working feedback. Such a definition of the concept in our research characterizes the didactic principles of consistency and systematicity.

Modern educators B. Korotyaev, V. Kurilo, V. Tretyachenko [2] point out that "under the educational space we understand everything that is created by human labour with the aim of educating, training and educating the younger generation. It includes entire set of specially created educational institutions, equipment, books, textbooks, technology, programs and policy documents, projects, etc."

Considering the concept of "educational space", we interpret it as a system of subjects interconnected in a certain way, having objective educational interests and able to interact in order to ensure production and reproduction processes. Over the past few decades these definitions have been significantly revised and adapted by Western European scientists K. Huutoniemi V., Boix Mansilla, E. Dawes Duraising, M. Borrego, R. Barro and others [6-12], and the range of conceptualization is varied. Some researchers seek to capture the nature of the interactions (for example, symmetrical or asymmetric, which includes the union of two or more disciplines) [13]. Each study embodies preferred epistemological mechanisms for disciplinary integration and favours certain implementation criteria by which interdisciplinary ideas are evaluated. First, the discipline should not be the central construct for research, but the research question should determine the disciplines that are involved in the educational process [13-15]. Second, the multi-, inter- and transdisciplinary are often seen as points on a continuum rather than mutually exclusive typologies [15].

The purpose of the work is to investigate the efficiency of the integration-lifelong approach in agroengineering education, built according to the integration principle and aimed at the formation and development of various levels and types of professional competencies among the future specialists in higher education.

Materials and methods

To achieve this goal, the following research methods were applied: theoretical analysis of philosophical, psychological and pedagogical literature on the topic of the research in order to select and comprehend factual material; analysis of concepts, theories and techniques, in order to identify ways to solve the problem under study, questioning, testing, generalization of the results, methods of mathematical statistics.

The process of training agroengineering specialists is based on a competent approach to the study of all disciplines in all cycles of study at the university. Traditionally, the disciplines of the general education cycle in terms of the content of the study methodology are almost the same for all areas and specialties. The technology of the competency-based approach requires fundamental changes in the organization, content and methods of the educational process. This is, first of all, transfer of emphasis from theoretical training to theoretical and applied, professionally oriented training. This particularly applies to the fundamental disciplines, in particular physics, as the most universal basic disciplines.

As another direction should be considered the lifelong formation of the students' professional competence through the performance of independent and practical work, fixed by the regulations, which are components of a qualified work in the future, the graduation project (work). In addition, a significant part of the laboratory work, practical and independent work will be of the nature, ordered by the coordinator of the qualification work; it will have elements of professional competence and scientific research. The main task in planning independent activities of the students in the educational process is to theoretically substantiate and develop a model of integration-lifelong work in training specialists in the agrarian and technical educational institutions for educational degrees (OS) "junior specialist" – "bachelor" – "master" (Fig. 1).

A significant part of the agrarian and technical universities (faculties) have transferred the implementation of individual independent work in the educational sector of planning and implementation to the scientific one. This is the basis for combining thoroughness in the educational process with thoroughness in the scientific work. For this, methods have been developed for compiling and implementing integrated end-to-end schemes for the implementation of educational and scientific qualifying works by each student, starting from the first year.

Consequently, the pedagogical model of an integration-lifelong educational space should include a set of conditions, aimed at developing the student skills to apply, to a greater or lesser extent, knowledge in various academic disciplines in the future professional activities. To develop these skills within the framework of the educational and cognitive activity is possible only if special didactic conditions are met. For example, when a student applies the knowledge of a discipline in the process of its studying to objects related to future professional activities, as well as when studying other disciplines - in new situations [2; 14]. In the approaches to building an integrated educational space of a university, practice (practical actions) should permeate the entire process of preparation of a student, starting with adapted initial courses. This is being implemented in the form of elementary functions of measurement, the use of objects of activity, continuing in the final courses of bachelor training in the form of independent solutions for the maintenance, debugging of agricultural machines, readiness to take responsibility for technical solutions, improving on the master's cycle, supplementing previous competencies with a level of research skills, non-standard approaches, and the search for alternative solutions of professional problems. It is the practice of the applied aspect of actions that serves as a unifying mechanism for integrating the subject content of academic disciplines [13].

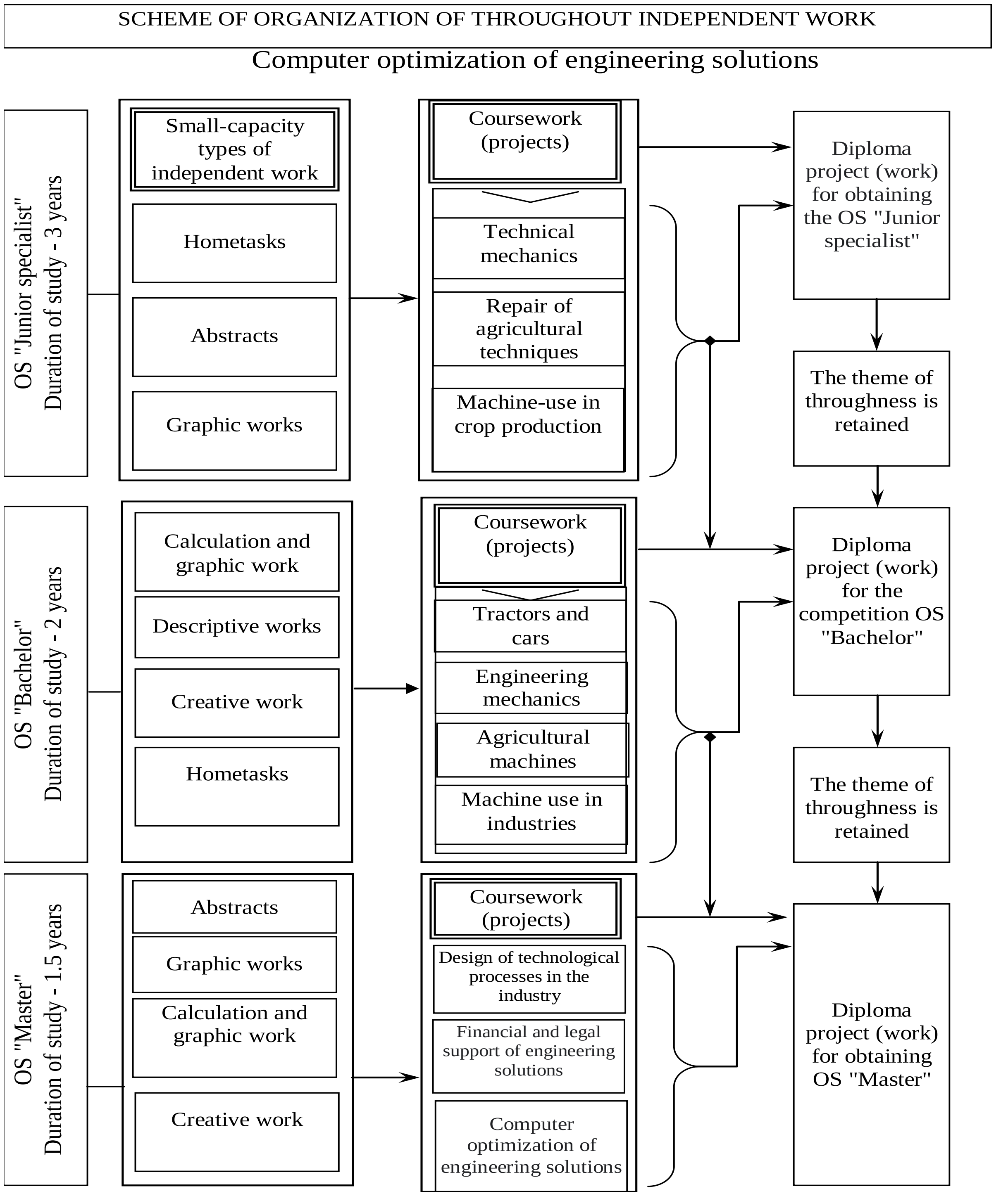


Fig.1. **Scheme of organization of the integration-lifelong educational space at agrarian technical universitya**

The developed concept of industrial training of the future specialists in the agro-technical direction takes into account the current trends, characteristics of the structure of industrial competence of specialists in the agrarian engineering direction; pedagogical patterns, principles and requirements that form the basis of the theory and practice of industrial training; variability of industrial training models for the future specialists in agrarian engineering. The very idea of industrial training is based on the concept of “learning throughout life”, which is understood as a continuous process of self-education and organized learning in the process of training and production activities. Each specialist must understand that, having mastered his specialty, he cannot stop at what he has achieved. For this any break means degradation of mastership, loss of professional skills. It is in this case that industrial training acts as a system of training, retraining and advanced training of the personnel [8]. Obviously, interdisciplinary connections should play an important role here, which manifest themselves as application of knowledge in one discipline while studying the content of another because of preservation of the theoretical and practical integrity of each of them. A special form of such training are integrated classes with aspects of education for sustainable development, which are aimed at establishing interdisciplinary links that contribute to formation in students holistic, systemic knowledge, actualization of a personal attitude to the issues considered [9].

However, other factors should also be included in the pedagogical model for the development of professional competence. The quality of professional education in universities will improve if the students develop interdisciplinary competencies when teaching natural disciplines, primarily physics. They will become the leading link in the process of forming future professional competence. The “optimum” point, in our opinion, can shift to one area or another, depending on the discipline and direction of the student training. For example, in teaching the physical and mathematical disciplines to the future engineer, quasi-professional activities can be multifaceted and play a primary role; it is limited to creating an “atmosphere” of scientific research, and the fundamental contribution to the development of competence here is made by the experience of interdisciplinary application of the physical and mathematical knowledge. Transition of higher education from training of a junior specialist to training a bachelor and master shifts the focus in understanding the goals of education: professional competencies related to specific industries fade into the background while general scientific competencies, associated with fundamental training, come to the foreground. It is in the fundamental training that the accumulation of the structural components of the future professional competence begins, first of all, the knowledge of the corresponding conceptual apparatus. Thus, for the development of a student’s competencies, a higher quality of his knowledge is necessary.

The methodological system, proposed by us, for building an integration-lifelong educational space of a university, optimally synthesizes the following basic conditions for organizing the process:

- organization of quasi-professional activities in practical and laboratory classes, modelling the complex application of knowledge;
- taking into account the importance of interdisciplinary integration at all stages of teaching subjects, first of all, systematic application of educational and cognitive tasks that simulate situations of interdisciplinary use of knowledge;
- creating opportunities for a student’s personal and professional self-development and self-realization, development of the necessary abilities, taking into account the individual peculiarities of his thinking (for example, the ability to analyze phenomena and their emotional coloring, spatial representations, pragmatic “engineering” thinking or creative thinking);
- creation of prerequisites, aimed at strengthening motivation of the future engineers to study the subject content of academic disciplines, increasing their cognitive and educational activity (the rating system, writing essays, elective courses, project method, etc.).

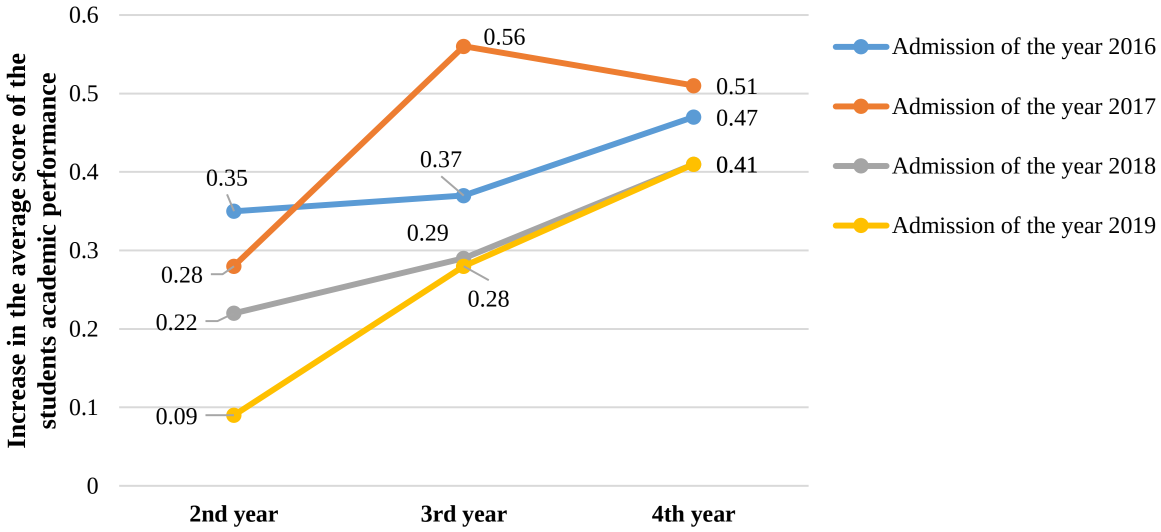
To substantiate the introduction efficiency of the integration-lifelong educational space in professional training of the future agricultural engineers, an analysis of its results was conducted, using statistical methods. The mathematical apparatus for processing the results of the experiment is based on formulas for determining the average score of all samples, their variances, the parameters through which they are compared and, with a probability of 0.95, they declare the presence or absence of a significant difference.

The efficiency of end-to-end work was studied from 2016 to 2021, for the students enrolling in the years 2016, 2017, 2018, 2019 for the Bachelor’s degree and in 2018, 2019, 2020 - for the Master’s degree. Besides, the experimental research work was performed in the following order: the initial level of students from the academic years 2-4 of the National University of Bioresources and Nature Management of Ukraine, specialty “Agroengineering” (a total of 200 applicants for higher education), as well as the Podolsk State Agrarian and Technical University (a total of 350 applicants for higher education). This made it possible to form experimental and control groups of students. Since there were 4 groups in the courses where the experiment was conducted, we selected three experimental groups where introduction of a cross-cutting approach in engineering education, built on an integration principle, took place. A reference group was also selected for comparison.

When introducing pedagogical technologies, new methods and techniques, methodological developments, manuals or textbooks, there is a need to compare their efficiency against the background of the classical basic ones and make decisions about the expediency of their use. The solution of such a problem comes down to comparison of certain sets of estimates (variation series of estimates). It is best to compare variational series by the arithmetic mean. In this case, the errors (oversights) that may occur by chance, are levelled.

Results and discussion

Analysis of the examination sheets of the set of students for the period of studies of 2016, 2017, 2018, 2019, when obtaining the scientific degree “Bachelor”, showed that the average increase in academic performance (average score) in the experimental groups was, respectively, in the second year - 0.23; III - 0.37; IV - 0.38, which is from 10 to 25% of the reference group (Fig. 2).

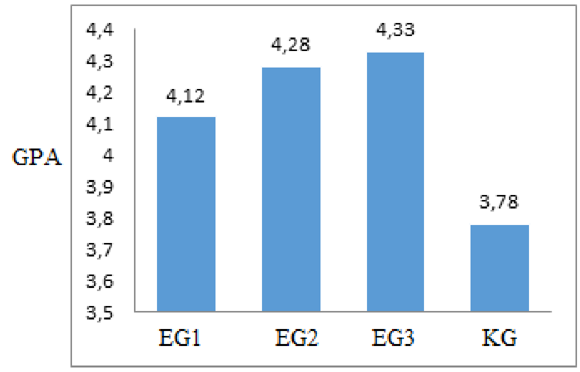


2nd year 3rd year 4th year

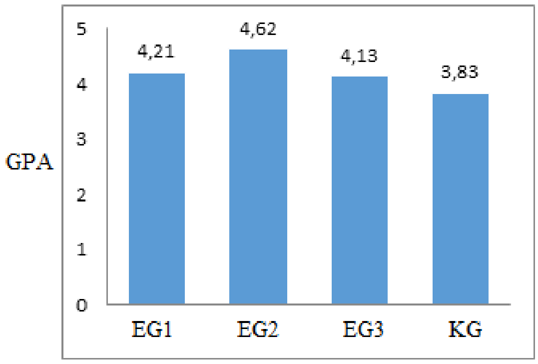
Fig. 2. **Dependence of the intensity increase in the average score of the students in the experimental groups, compared with the reference ones, by the academic years (scientific degree “Bachelor”)**

Analysis of the results of the experiment for the educational degree “Bachelor” showed the efficiency of the end-to-end technology for teaching students. In the experimental groups the average score was higher than in 2016 by 15%, in 2017-2019 - by an average of 12% (Fig. 3). A peculiar feature of the experiment with these groups was that it operated within one academic year, it was as transparent and manageable as possible, there were practically no “blunders”. This emphasizes the efficiency of a technology in the short-term programs – within the same discipline, academic year, and in the long-term programs – the educational and qualification levels. It has been proved that the interest in end-to-end design is most clearly manifested with the students from the senior academic years. In addition, a significant part of the senior students, working on certain topics together with the junior students, become their co-supervisors in the process of completing the course projects. This allows to free up the time of scientific and pedagogical workers to solve more complex problems of the educational process.

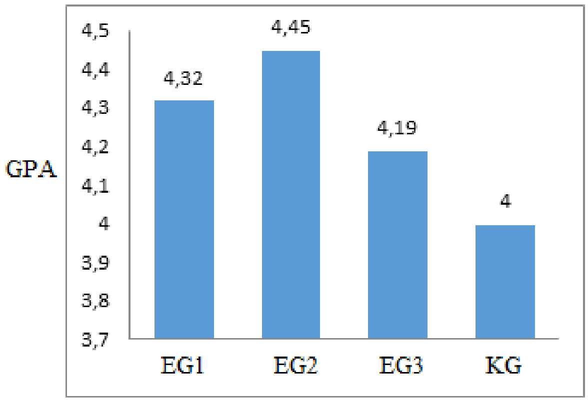
Introduction of an end-to-end system of planning and implementation of independent work into the educational process showed that the academic performance, compared with the reference groups, increased from 3 to 15% in the junior groups, and up to 30% in the senior ones, which indicates its expediency and pedagogical efficiency. The difference in the performance indicators between the junior and the senior students can be explained by the growth of psychological stability and increase in the students' awareness of the main idea of thoroughness - orientation to personality and its needs, private interest, exclusion from the learning process of elements of aimlessness and the presence of a vector of educational activities, aimed at the final result.



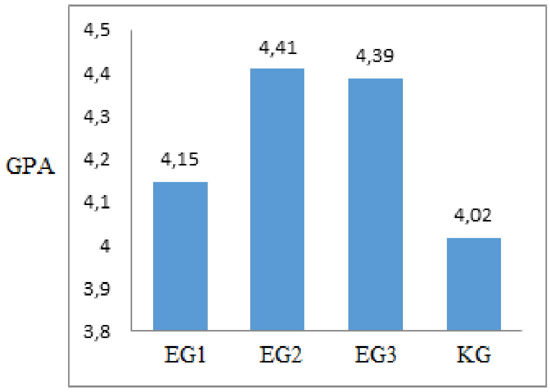
Enrollment in 2016



Enrollment in 2017



Enrollment in 2018



Enrollment in 2019

Fig. 3. **Grade point average (GPA) of students of enrollment in 2016-2019:**
EG1– 1st experimental group; EG2 – 2nd experimental group; EG3 – 3rd experimental group;
KG – control group (scientific degree "Bachelor")

Conclusions

1. Training of the future specialists in the agro-technical direction should reflect the specifics of training under the conditions of a higher educational institution, which manifests itself in the continuity of integration-lifelong training, which is ensured both at the content-technological level and at the level of individual practical training for the production activities. As a result of the experiment, there has been proved the efficiency of the proposed model for organization of the integration-lifelong organization of the students' educational activities.
2. It was revealed that the proposed methodology has a positive effect onto the students' progress and activity, which is expressed in the results of the experiment. The results of the pedagogical experiment demonstrated an increase in the absolute indicator of progress of the junior-year students by an average of 9%, the senior-year students - up to 30%, which indicates the efficiency of the proposed methodology for the integration-lifelong organization of the students' educational activities.
3. The impact of specially organized professionally-oriented activity of students in physics has been revealed upon the motivation of learning and professional orientation. At the same time, motivation to study physics increased by 7%, professional orientation by 11%. Consequently, the increase in the levels of educational achievements of students, the growth of levels of motivation and professional orientation testifies to the efficiency and pedagogical expediency of the proposed methodological principles of integration-lifelong organization of the students' educational activities.

Author contributions

Conceptualization, S.N.; methodology, S.N., V.I. and O.B.; formal analysis, V.I. and L.Z.; investigation, O.B., L.Z.., V.S. and V.V.; data curation, V.V. and V.S.; writing – original draft preparation, L.Z., I.D.; writing – review and editing, I.D., O.B. and V.I.; visualization, I.D. and O.B. All authors have read and agreed to the published version of the manuscript.

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