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Forms and methods of professional development for biology teachers

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Abstract: This article explores various forms and methods of professional development for biology teachers within the modern education system. Given the constant evolution and change in biology, teachers must remain at the forefront of knowledge and pedagogical techniques to ensure quality education for their students. The article discusses different forms of professional development and analyzes the role of educational environments and postgraduate education institutions. The conducted survey highlights the significance of implementing professional development and motivating educators in their professional activities. The conclusions of the article are valuable for both biology teachers and educational institutions planning to develop support and training systems for pedagogical staff in the field of biological education. The authors emphasize that the professional development of biology teachers requires a combination of different methods and an active approach to learning. This is essential for the effective implementation of scientific achievements in the educational process and the provision of quality education in this field.

Keywords: *Educational environment, Forms of professional development, Methods of professional development, Professional development, Professional expertise, Qualification enhancement, Informal education platforms,*

1. Introduction

Ensuring the professional development of biology teachers is one of the crucial aspects of modern secondary education. Today's teachers face numerous challenges related to rapid changes in science, widespread dissemination of pedagogical technology, and renewal of teaching methods. Therefore, the continuous updating of knowledge and enhancement of professional mastery for biology teachers is essential for maintaining high-quality education.

The professional development of biology teachers not only improves their qualifications but also fosters the creation of new teaching approaches. Modern methodologies and interactive technologies make the learning process more engaging and effective, thereby increasing students' motivation and interest in the subject.

Furthermore, professional development aids biology teachers stay abreast of the latest scientific advancements. Biology as a science is constantly evolving, and teachers must be prepared to integrate new knowledge into their teaching practice. This ensures that students have access to up-to-date and verified information, which is a key factor in shaping their scientific worldview.

It is also important to note that professional development contributes to the personal growth of teachers, enhancing their ability for self-education and self-improvement. Participation in seminars, training sessions, and conferences creates opportunities for experience exchange, which is an invaluable resource for improving pedagogical practice.

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Ensuring the professional development of biology teachers plays a significant role in creating a positive educational environment. Highly skilled and motivated teachers can inspire their students, fostering the formation of critical thinking, analytical skills, and a love for science.

Consequently, it is no coincidence that a cornerstone issue in modern education is the professional development of teachers, which is enshrined in the legislation of Ukraine. The Law of Ukraine "On Education" (Article 7) [4] and "On Pedagogical Education" (Article 7) [5] define the basic principles and objectives of education including the continuous development of individuals and the necessity to improve the qualifications of teaching staff. The organization of professional development is the obligatory task of services of methodological providing. According to the resolution of the Cabinet of Ministers of Ukraine [20], professional development is aimed at supporting the quality of education and enhancing teachers' professional levels. Legislative changes provide pedagogical staff with opportunities for professional development through participation in educational programs and the attestation procedure. The selection forms and methods for professional mastery development are determined by the teachers' necessities and modern society's requirements. Postgraduate education tasks include developing the instructional content and the use of current techniques, moreover stimulating continuous professional development [9].

Considering the above, this *article aims* to identify and substantiate effective forms and methods of continuous education for biology teachers that will contribute to their professional development.

The research is grounded in the *hypothesis* that effective forms and methods of professional development for biology teachers in the modern educational environment, can play a crucial role in improving the quality of education, thereby contributing to students' understanding of biological sciences. This hypothesis is based on the premise that teachers with access to innovative methods actively integrate them into their pedagogical practices enhancing their teaching skills and motivating students to study biology. Investigating the impact of these forms and methods on the professional development of biology teachers can yield valuable insights for further enhancing the system of qualification improvement for pedagogical staff in the biology area of expertise.

1.1. Literature Review

The research on professional development for teachers focuses on defining the essence of this concept. The term "professional development" derives from the Latin word "profiteor," meaning "to declare one's profession." That approach to interpretation of this concept emphasises the irreversible transformation of an individual during professionalization [17]. Researchers identify related terms such as teacher development, career development, staff development, lifelong learning, and professional growth. "Professional development" is specified as the acquisition of new experiences, knowledge, and skills, transforming the motivation and interests of an individual [23]. According to Liudmyla A. Martynet's point of view, this process involves an active qualitative transformation of a teacher's inner self, leading to a new professional life, independent of age [15]. In pedagogical conception, it encompasses the activity of addressing cognitive, communicative, and moral tasks [15]. On the path of professional development teachers cultivate major qualities such as communicability, motivation, reflexivity, pedagogical mastery, and intellect [9].

Forms of professional development encompass various methods and approaches aimed at increasing skills and competence, both organized and self-directed, utilizing diverse techniques and tools. In line with the Pedagogical Dictionary, a "form of learning" pertains to the external aspect of educational organization, influenced by the interaction between subjects and the level of independence [22]. A "method" refers to a structured sequence of actions by teachers and students designed to achieve educational goals, utilizing appropriate means and following specific principles. Pedagogical expertise methods can be categorized into theoretical methods for knowledge acquisition, practical methods for skill development, semi-professional methods aligning knowledge with professional activity, and self-study methods [7].

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1.2. Analysis of Professional Development Methods and Forms

Based on the analysis of primary sources, it can be argued that methods for developing pedagogical mastery can be conventionally divided into four groups, such as (1) theoretical methods focused on acquiring knowledge; (2) practical methods aimed at gaining specific skills and competencies; (3) semi-professional or orientation-oriented methods designed at aligning vital knowledge and skills with professional activity; and (4) self-study methods [6].

Concerning the forms of professional development for middle school teachers, they can be classified in the following ways: formal and informal ones. Let's examine each of them in more detail.

The formal form encompasses directions such as:

- Activities, that are conducted by professional development providers, for instance, seminars, workshops, forums, online learning, etc.;
- Activities, are offered by schools and employers, such as professional development days, research projects, and mentorship programs;
- Presentations at conferences or workshops;
- Obtaining additional educational qualifications or academic degrees.

Conversely, the informal form involves:

- Reviewing and working with subject-specific literature;
- Professional or collegial meetings focused on teacher learning or the analysis of pedagogical activities;
- Participation in educational policy development or its implementation, and other informal means of professional growth [12].

A combination of these methods and forms can contribute to continuous professional development for biology teachers, assist them keep their knowledge up-to-date and enhance the learning process.

Numerous countries around the world introduce their unique approaches and methods for the professional development of teachers. Their proposed *courses and programs for qualification improvement and retraining for pedagogical staff* elicit considerable interest and are worthy of replication.

In Moldova, the coordination and monitoring of adult education is carried out by the Department of Certification and Professional Development of the Ministry of Education and Youth. Forms of continuing education include courses, internships, seminars, distance learning courses and other forms. Professional development is implemented according to framework programs that actualize teachers' knowledge of the profession, didactics and psychology. The program's goal is to provide a balance between subject-based learning and professional training. Such a strategy allows teachers to desine their programs based on interests and aspirations.

It should be highlighted, that France, Finland, and the United States showcase various approaches to organisation the continuous professional development for teachers.

In France, teachers are trained within post-graduate institutions, higher educational institutions and regional education centres. Such diversification forms of teachers' professional training promote the renewal and deepening of their professional knowledge and adaptation to the real challenges faced in educational institutions and society.

In Finland, teacher training is continuously organized at the level of academic institutions, particularly the National Board of Education and the National Center for Professional Development in Education. Common forms of professional education include targeted, cascaded, collaborative, and case-based learning [7].

In the USA, pedagogical staff are trained through higher educational institutions of various levels. Advanced training programs are available both full-time and part-time, and cover diverse aspects of professional pedagogy. Teachers' associations serve the function of improving the quality of education and teacher development by providing support and access to a variety of resources [7].

The legislation in the field of education in Ukraine defines strategic goals and tasks and regulates the forms and methods of training and retraining of teaching staff.

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In the "Recommendations on Adult Education Development," it is stated that adult education should stimulate and support the interests of adults who are learning, relying on their experience, and confidence, and ensuring their active participation at all stages of the educational process. Education should be adapted to the personal qualities, age, family, social, and professional status, living conditions, and the nature of the relationships between these factors. Methods for adult education have to contribute to the formation of skills in tolerance, participation, mutual support, collaboration, and teamwork [1]. The strategy for the teachers' mastery development must include certain principles that ensure the consideration of the needs and the stage of the professional development of the specialist and direct this process towards addressing the real challenges of professional activity [8]. The geopolitical situation in the world, specifically the military conflict in Ukraine, has led to changes in the organization of the educational process in educational institutions. Reforms have not spared educational programs for teachers' professional development. In terms of Ukraine, the short-term competency-oriented thematic courses for teacher professional development have been designed and proposed to meet the current demands of the teaching staff, aligning with the imperatives of the moment.

Some important points of this new policy are focused on the following aspects :

1) the urgency of improving teachers' digital competence;

2) the implementation of modern pedagogical technologies, which directly affects the quality of the educational process;

3) the critical necessity for psychological support for all participants in the educational process [11].

The transformation of modern educational systems is based on the recognition of the leading role of the teacher in introducing new methods and forms of organizing the learning environment. Today, teachers can choose the location, form, and content of continuous education. The aim of the professional development of biology teachers includes acquiring skills and competencies in organizing the learning process, using knowledge for developing specific courses in secondary school, applying innovative teaching methods, and planning and self-organizing their professional activities in the field of secondary education [3]. According to the law of Ukraine "On Adult Education," the educational process in non-formal adult education is organized through various events and projects for adults. These cover seminars, workshops, training sessions, webinars, courses, and educational projects for adults, which are determined by the provider of educational services in adult education. V. Burenko points out that the work with pedagogical staff should rely on an andragogical approach and consist of several elements, with the following being the most significant:

1. Teaching methods.
2. Motivation for learning.
3. Principles of adult learning.
4. Principles of pedagogical creativity of the teacher [2].

Institutes of postgraduate pedagogical education and professional development courses can become important centres of formal and informal education for teachers. Additionally, increasing one's qualifications and readiness to work in specialized schools can be achieved through collaboration with higher education institutions and research organizations [16].

In institutions of postgraduate education, the teachers' self-training is actively advancing, providing them access to innovative educational environments. In particular, teachers can independently process information and develop skills via various communication tools and consultations with the curators of their scientific groups. In the practice of adult education, in the process of professional development of biology teachers, a set of active didactic forms and methods are considered and implemented as a multifunctional system, as a method of pedagogical management, as an activity element of the content of education, as a project of educational activity and as a form of organization of the educational process.

An effective form of learning is interactive lectures. The advantage of their application in the educational process lies in the fact that the knowledge and skills acquired through active dialogue are deeper, more systematic, better retained, and increase teachers' interest in the study material. An

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interactive lecture should not be considered merely an informational method; rather, it is a problem-solving and exploratory method of professional development for biology teachers [19].

Yet another engaging form of professional development for teachers is master classes. As a form of short-term training, master classes are interesting and effective for sharing experience and creative work in the occupation field. The training acts as an interactive form aimed at professional self-improvement and changing models of management of teachers' behaviour and activities [2; 8]. The use of case study (case method) is a popular tool for teachers' professional development given this method is innovative and effective. Undoubtedly, a case study promotes a comprehensive analysis of situations in an open discussion, shapes collective decision-making skills and allows teachers to independently solve non-standard tasks [18].

One of the crucial elements in enhancing teachers' qualifications is the information environment of the general secondary education institution. Definitely, such an environment stimulates the exchange of experience, and participation in collective projects, study groups and seminars, which contributes to the improvement of the teachers' competence. The educational environment of secondary schools promotes the professional development of teachers through the exchange of pedagogical experience, participation in collective projects, involvement in study groups, mentoring, and access to professionally valuable resources [13; 14]. The educational environment of general education institutions facilitates the continuous professional growth of educational workers, assists them adapt to changes in the modern educational process and improves the quality of their work.

Practically, traditional forms of course training remain popular among biology teachers, but in the current situation, innovative forms of their professional development are coming to the forefront. The increase in ICT or digital competence of teachers allows the use of electronic coaching and mentoring [9]. Cloud computing technologies are also used to organize communication and collaboration in group and individual work with teachers [10].

With the participation of the institutes of post-graduate education of pedagogical personnel, the forms and methods of training are being actively implemented to improve the qualifications of teachers. These institutions organize short-term courses, sessions and master classes for teachers which skilled deal with differentiated learning in specialized educational institutions, such as special lyceums, gymnasiums and specialized classes with a natural sciences orientation [16].

It should be summarized, that in the developed countries of the world, the professional development of teachers is based on general principles, such as a comprehensive systematic projection of reality onto the educational process, an integrated connection between social aspects and scientific reality, the principles of autonomy, diversity and constructivism. It is necessary to point out, that the general development of teachers' professional mastery is based on a variety of resources, including empirical, technological, personal, ethical, ideological, interdisciplinary and pedagogical ones [7; 18].

2. Methods

The study primarily used theoretical methods including retrospective and comparative analysis, generalization, and systematization to examine effective forms and methods of professional development for teachers. Theoretical analysis of legislation and scientific works on the issue allowed us to identify the main approaches to the organisation of adult education and its major forms and techniques.

To study biology teachers' opinions on effective forms and methods for their professional development the empirical approach has been used and the custom questionnaire has been developed. The questionnaire included 13 questions with proposed answer options, and teachers could also suggest their answers. The survey was conducted using a Google form. Participation was voluntary. Twenty-six biology teachers from Bila Tserkva, varying in age and professional experience, participated in the study. The obtained results have been considered for making objective conclusions about the effectiveness of professional development forms and methods and for preparing recommendations on their use.

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3. Results

The analysis of the questionnaire results from biology teachers provided the following revealing data. First of all, it should be noted that the study involved teachers with varying lengths of teaching experience in biology (see Figure. 1), namely: less than 5 years (20%), 5-10 years (35%), 11-20 years (30%), 21 years and more (15%).

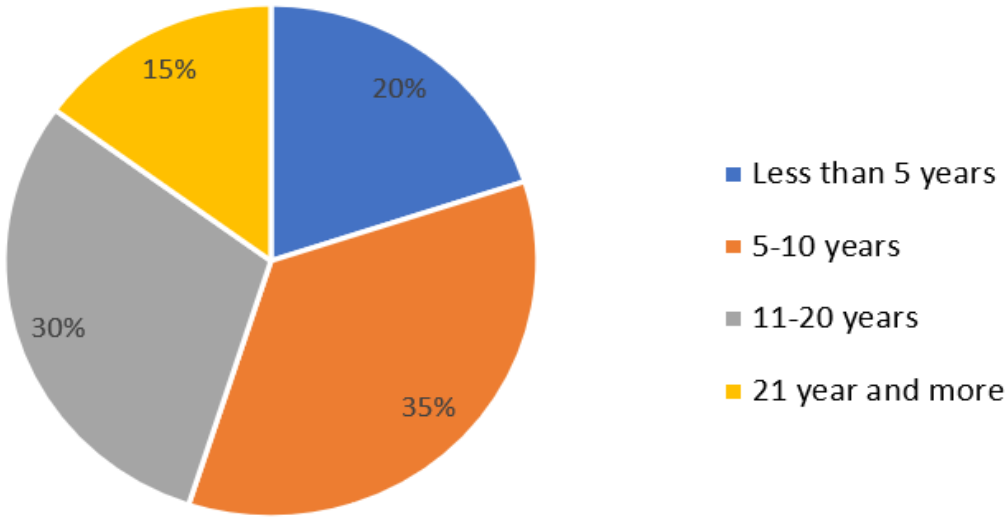

Figure 1.
Results of responses to the question: "years of biology teaching experience".

The obtained results of the questionnaire are presented in the following diagrams.

The frequency of teachers' participation in professional seminars and conferences over the past year was determined. It was found that 20% did not participate whatsoever, 40% - in 1-2 events, 30% - 3-5 events, and more than 5 events pointed out only 10% of respondents (it is shown in Fiure. 2).

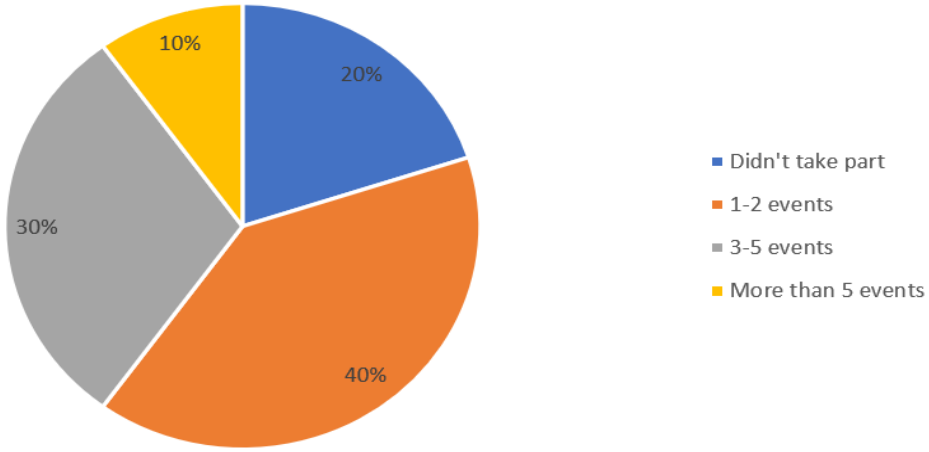

Figure 2.
Results of responses to the question: "Frequency of participation in professional seminars and conferences in the last year".

The survey results identified the professional development methods practised by biology teachers (Figure 3). Among them are: participation in online courses (60%), attending workshops (40%), reading

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specialized literature (70%), conducting research in the field of biology (20%), teaching scientific disciplines (20%), participation in professional associations (30%).

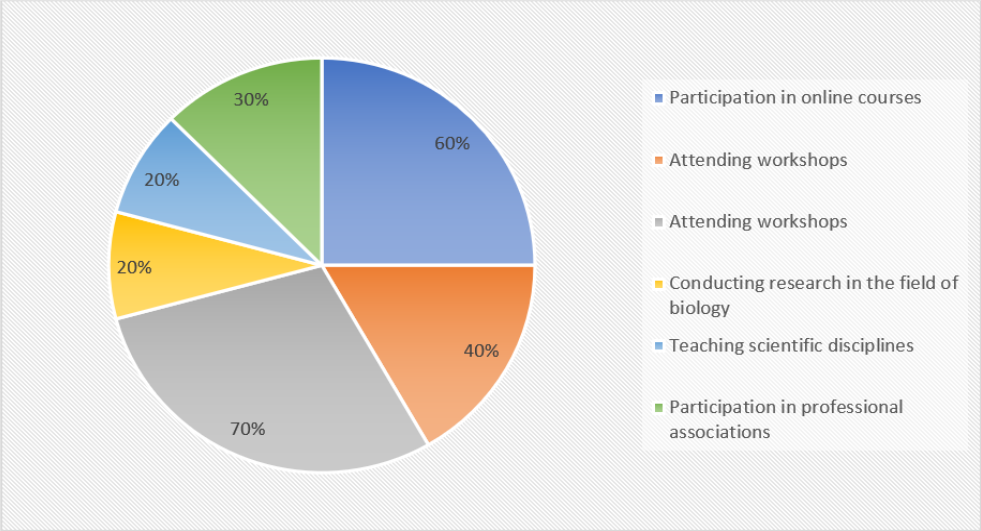

Figure 3.
Results of responses to the question: "Methods of professional development used during professional activities".

The survey highlighted several major difficulties teachers face during their professional development, including (see Figure 4): limited access to up-to-date information (45%), lack of time for learning (30%), insufficient financial resources to participate in events (20%), and lack of motivation (5%).

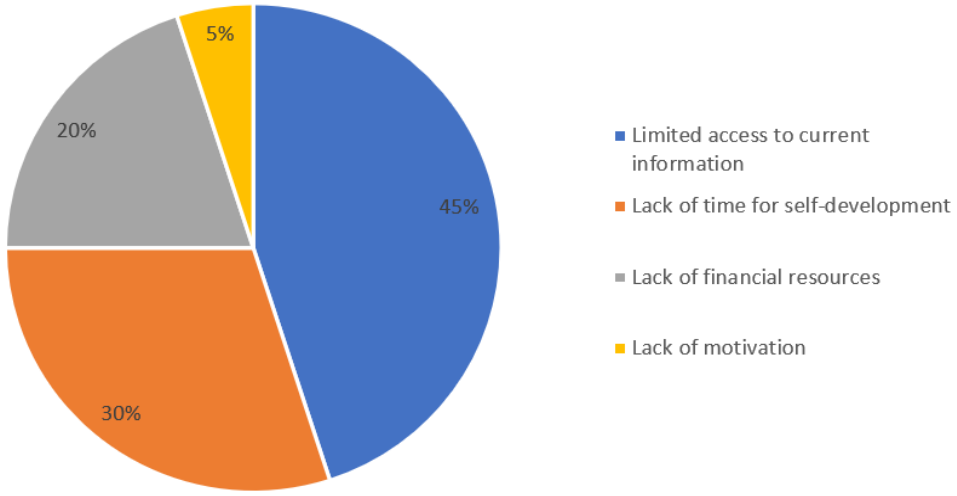

Figure 4.
Results of responses to the question: "Main challenges encountered during professional development".

The forms most commonly used by biology teachers for their professional development were identified (Figure 5). These cover participation in scientific conferences and seminars (38%), online courses and webinars (26%), self-education via scientific publications and literature (24%), collegial

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discussions with employees (12%).

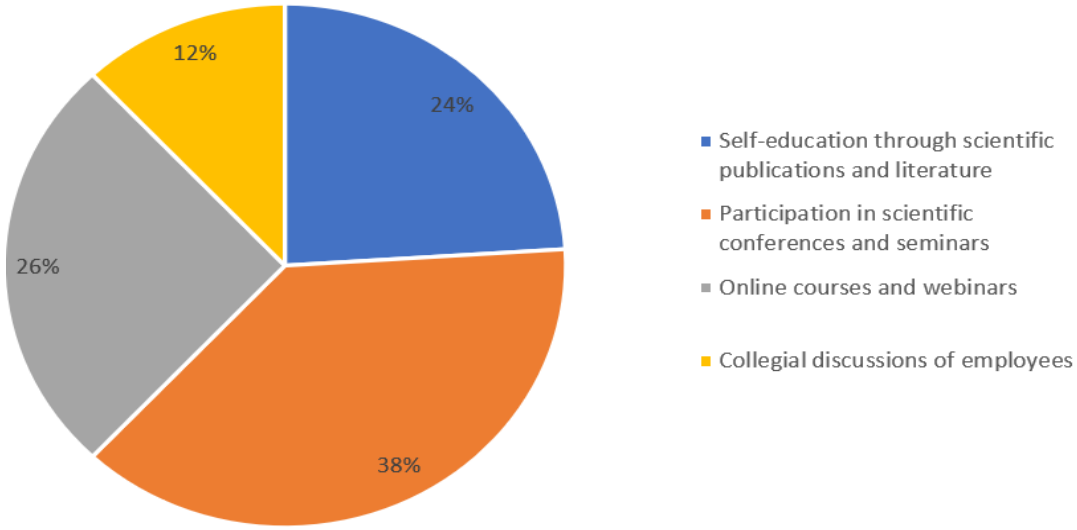

Figure 5.
Results of responses to the question: "Which forms of professional development do you use most frequently?"

Teachers expressed their views on the necessity of continuous professional growth. According to the data in Figure 6, 58% believe that without updating knowledge, it is impossible to teach new study material effectively; 23% pointed out, that basic knowledge is also important, sometimes more than anything else; 19% argue, that professional development is essential but not always possible due to limited time. It is noteworthy that none of the respondents consider their existing knowledge sufficient for effective and productive professional activity.

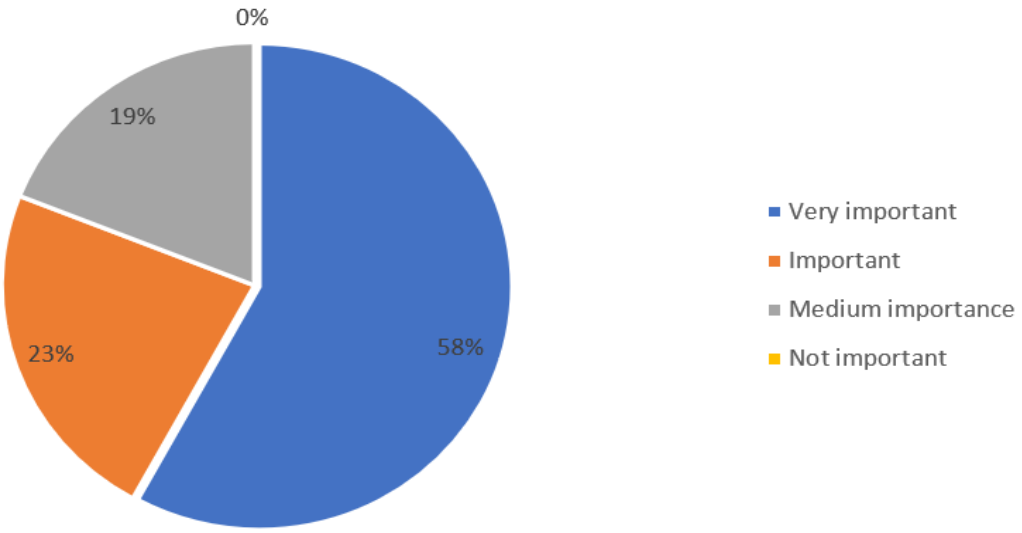

Figure 6.
Results of responses to the question: "How do you assess the importance of continuous professional growth for a biology teacher?".

Among the forms of professional development, teachers most frequently utilize (Figure 7): working

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in groups to exchange experiences and ideas (46%); individual consultations with experienced colleagues (15%); mutual classroom observations and lesson discussions (24%); internships in scientific laboratories or companies (15%).

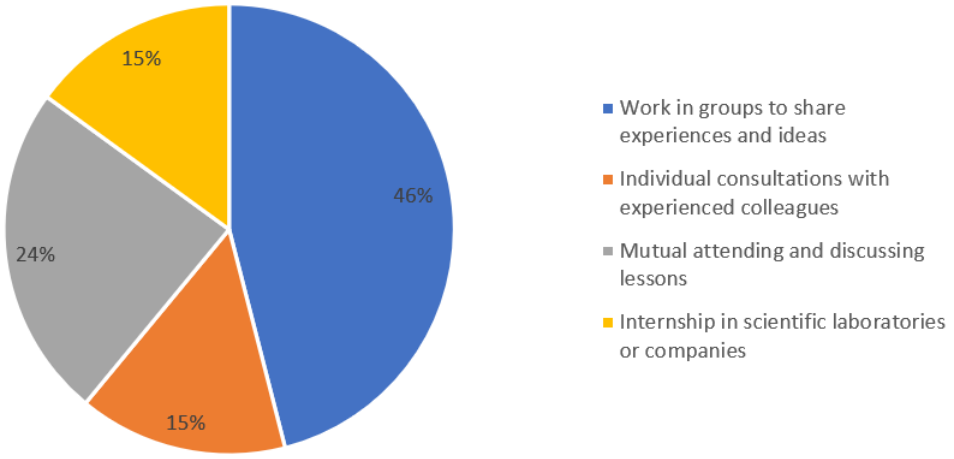

Figure 7.
Results of responses to the question: "Which teaching methods do you consider most effective for the professional development of biology teachers?".

It is found, that teachers incorporate scientific research data in their work in the following ways (Figure 8): 26% use the latest research findings to update the study material; 31% occasionally integrate single scientific discoveries into the educational process; 31% rely more on traditional methods; meanwhile the 12% not using scientific research in their teaching.

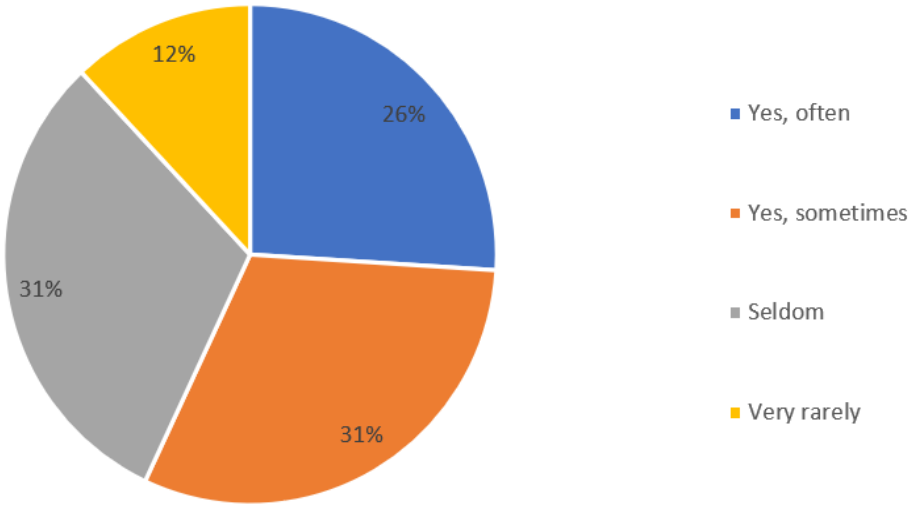

Figure 8.
Results of responses to the question: "Do you use scientific research in your teaching? If So, How?"

In the list of professional growth forms, teachers chose the following as their preferences (Figure 9): organizing and participating in scientific discussions together with colleagues (23%); attending practical

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masterclasses and lectures from experts of the branch (16%); collaborating with higher education institutions to acquire new profession knowledge (38%); participation in training sessions (23%).

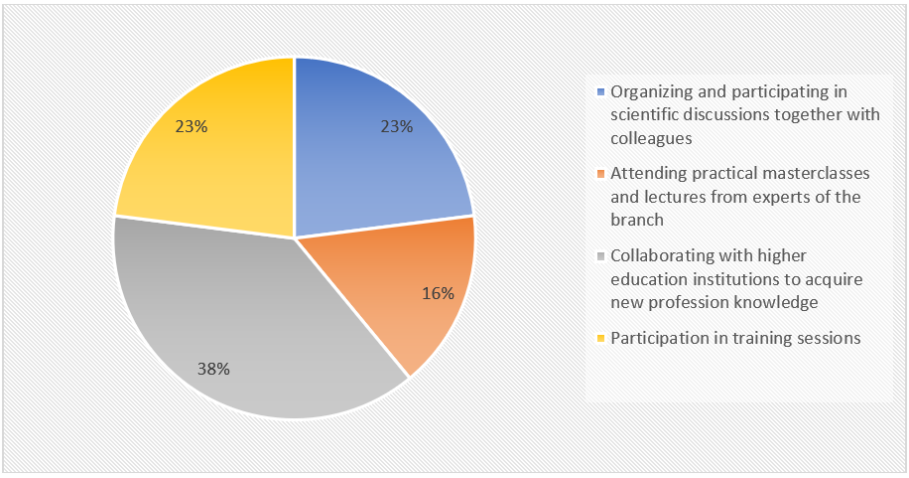

Figure 9.
Results of responses to the question: "What forms of professional development would you like to see in your professional activities?"

Teachers assess the importance of continuous learning for maintaining the quality of biology teaching in the following way (Figure 10): only through continuous learning can one remain relevant in the modern educational environment (42%); learning allows for updating knowledge and implementing new methods in the teaching process (29%); core knowledge remains constant, sometimes active learning is not required (29%); some knowledge is already sufficient for teaching (0%).

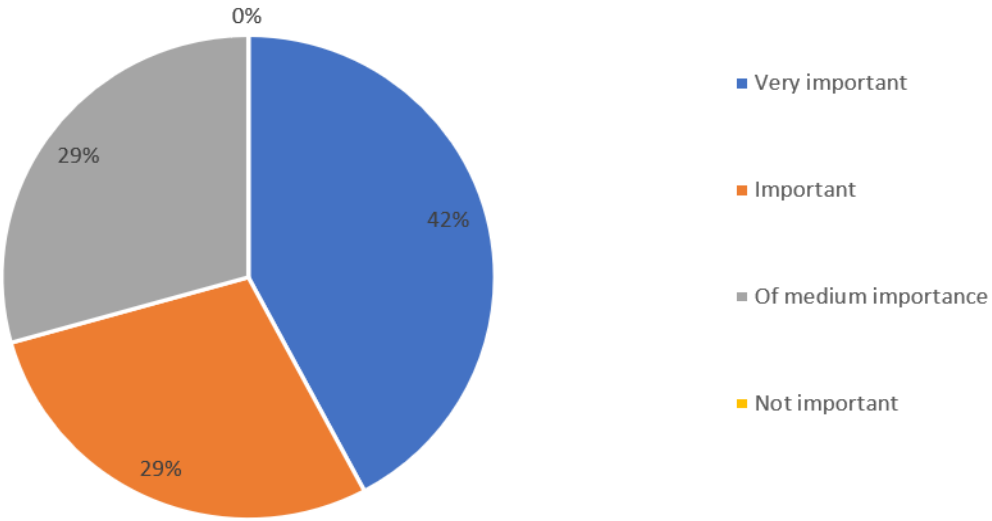

Figure 10.
Results of responses to the question: "How do you evaluate the importance of continuous learning for maintaining the quality of biology teaching?".

Biology teachers highlighted the following methods (forms) of professional development as being the most effective in enhancing the quality of instruction (Figure 11). These are active participation in scientific research (38%); regular exchange of experiences with other teachers (23%); the application of

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innovative approaches in teaching practice (31%); participation in specialized workshops and training sessions (8%).

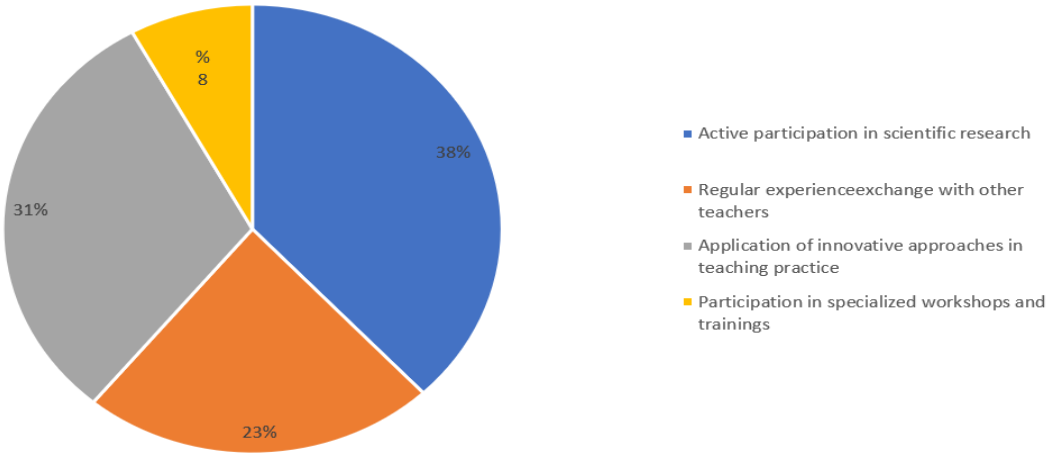

Figure 11.
Results of responses to the question: "What methods (Forms) of professional development do you consider most effective for improving the quality of your teaching?".

Teachers utilize the advancements of modern pedagogical science in the educational process in this way (Figure 12): actively using new teaching methods and technologies to enrich the study material (65%); occasionally incorporating interactive teaching methods (20%); relying more on traditional methods (15%); not using current approaches (0%).

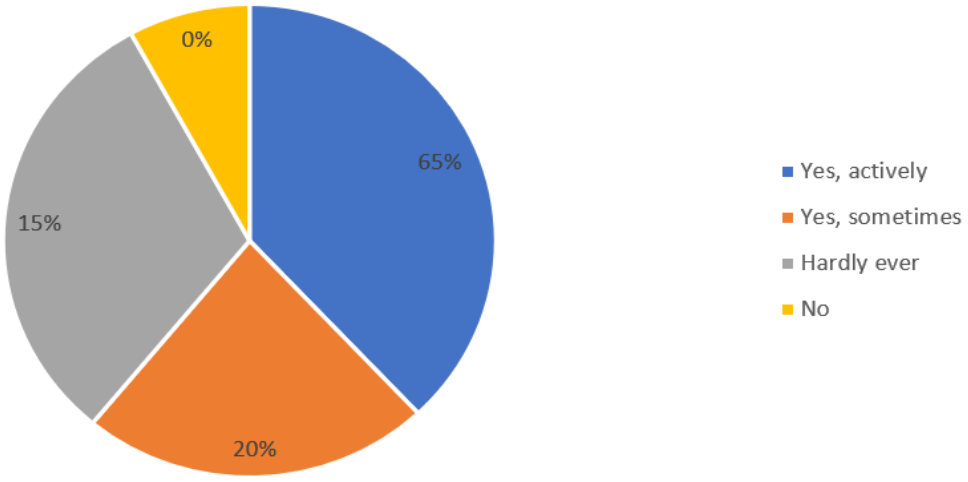

Figure 12.
Results of responses to the question: "Do you use the achievements of modern pedagogical science in the teaching process?"

Teachers in Ukraine have a significant number of opportunities for professional development due to various educational initiatives (Figure 13). One of them is organizing regular scientific symposiums with expert presentations (31%). The second way is designing specialized online courses for

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qualification improvement (31%). Yet another is financial support for internships in scientific laboratories (7%), as well as providing access to specialized publications and research resources (31%).

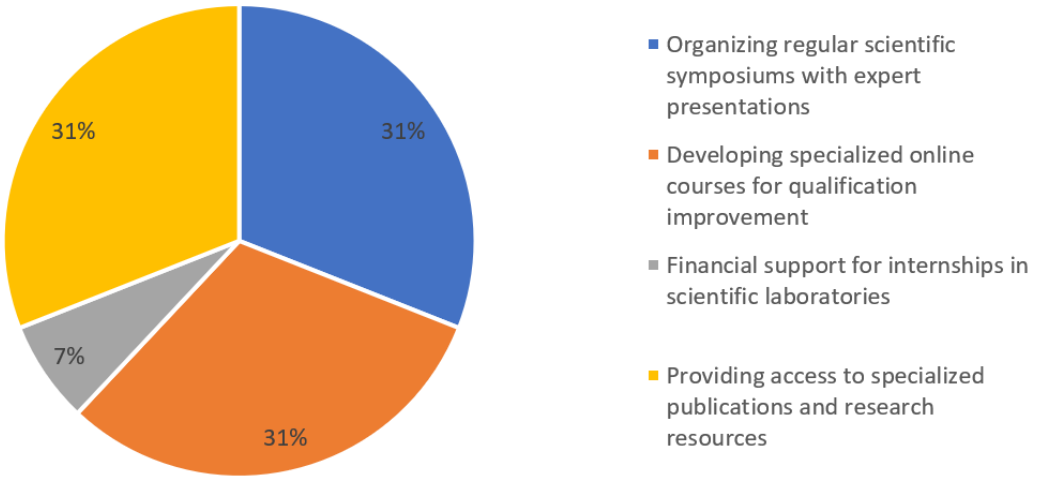

Figure 13.
Results of responses to the question: "What methods (Forms) of professional development would you like to see in programs supporting biology teachers?".

In terms of platforms for professional self-development, teachers highlighted «EdEra», «For the Lesson», «Education UA», «Teacher's Portal», and «Center for Education and Development». In the opinion of teachers, these resources provide access to a variety of training and enriching courses and study materials. It should be noted that the use of educational platforms and cloud technologies is a promising direction that not only has a positive effect on the organisation of student learning but also allows teachers to operate resources and online educational opportunities. The use of cloud computing technologies in teachers' professional activity, such as G Suite for Education, is becoming a future-oriented direction which facilitates interactive education and the exchange of experiences [10]. Generally, these initiatives aid teachers to actively improve their skills, encourage the exchange of experience and contribute to the improvement of the quality of education in Ukraine.

4. Discussion

The research revealed the needs of the teaching staff of Bilotserkivskyi district in the organisation of more appropriate professional training. In particular, among the effective forms and methods of professional development, the biology teachers highlighted the following points:

- It is *self-education*, that involves teachers taking the initiative to study independently, which can include reading relevant literature, engaging in online courses, and staying updated with the latest scientific discoveries. Self-education empowers teachers to continuously enhance their knowledge base and stay current with educational advancements.
- *Participation in scientific conferences and seminars* allows teachers to network with peers, share their experiences, and learn about current research and innovative teaching methods. These interactions can inspire new teaching approaches and provide fresh insights into biological sciences.
- *Online courses and webinars for qualification improvement.* It is the flexibility of online learning platforms that is particularly valuable. Teachers can choose from a wide range of courses that fit their schedules, enabling them to acquire new skills and knowledge at their own pace. This mode of professional development is especially beneficial for those balancing professional duties and

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personal commitments.

- *Internships in scientific laboratories or companies* shape the new experience facilitating teachers to apply theoretical knowledge in real-world settings, gain hands-on skills in modern technologies and methodologies, and bring back practical insights to their classrooms. These internships can significantly enhance the teaching of complex biological concepts.
- During the *mentoring* skilled teachers can guide less experienced colleagues, sharing best practices and providing support. Mentoring fosters a collaborative learning environment, encouraging continuous professional growth and development.
- *Collaboration with higher education institutions to gain new knowledge* provides access to cutting-edge research, advanced teaching materials, and expert knowledge. These collaborations can lead to joint projects, workshops, and the development of innovative teaching strategies.

It is worth mentioning that modern technical capabilities allow teachers to delve deeper into the process of professional development without leaving their work, using online platforms to effectively balance their time between self-education and on-the-job training in a 24/7 format. This seamless integration of professional development into daily routines ensures that teachers can continuously improve their skills without compromising their teaching responsibilities. Furthermore, the use of digital tools and resources can make professional development more accessible and customizable, catering to the specific needs and interests of individual teachers.

5. Conclusions

Based on the results of theoretical analysis and empirical research on the problem of organizing professional development for biology teachers, we can make the following generalizations.

The obtained data allowed for the identification of several new directions and concepts in the development of professional mastery for biology teachers.

It has been found, that biology teachers, who took part in our research, are highly engaged in diverse professional development activities, such as attending scientific conferences and seminars, pursuing self-education, and operating with information technologies. A pivotal aspect of their continuous education is the exchange of experiences. Teachers actively use scientific research to update their knowledge and integrate it into their teaching practices. A majority of teachers acknowledge the importance of collaboration with higher education institutions.

It has been noted that effective support programs for biology teachers include organizing online courses, providing access to educational resources, and facilitating the publication of their research. However, challenges such as limited access to current information and insufficient financial resources for participating in professional events are persisting. Interestingly enough, teachers emphasize that active learning methods, including interactive lectures, seminars, and webinars, are crucial for effectively assimilating new knowledge. These findings emphasize the dynamic nature of professional development for biology teachers and underscore the need for continued assistance and resource allocation to enhance their educational practices.

Drawing on these findings, several recommendations can be proposed.

Firstly, increase funding and resources to ensure teachers have access to current information and professional development opportunities. This can include investing in subscriptions to scientific journals, purchasing up-to-date textbooks, and providing access to online databases and educational platforms. Adequate funding can also support attendance at national and international conferences, where teachers can learn about the latest research and pedagogical innovations.

Secondly, expand collaboration programs between secondary schools and higher education institutions to facilitate knowledge exchange and support. Establishing partnerships with universities can create pathways for teachers to participate in advanced training sessions, joint research projects, and internships in cutting-edge laboratories. Such collaborations can foster a culture of continuous learning and professional growth, as teachers gain access to advanced academic productions and practical applications.

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Thirdly, design and promote online courses and webinars to provide flexible and accessible learning options. Online professional development programs can be tailored to meet the specific needs of teachers, offering courses in new teaching methodologies, subject-specific updates, and the integration of technology in the classroom. The flexibility of online learning allows teachers to engage with these resources at their convenience, making it easier to balance professional development with their teaching responsibilities.

Lastly, create a professional development environment within schools to support continuous teacher development. Schools can establish dedicated time for professional development activities, such as regular workshops, peer observation sessions, and mentoring programs. Creating a supportive environment where teachers are encouraged to share best practices and collaborate on innovative teaching strategies can lead to improved instructional quality and better student outcomes.

Overall, these recommendations aim to empower teachers by providing them with the necessary resources, opportunities, and support to enhance their professional skills and knowledge, ultimately leading to a more effective and engaging educational experience for their students.

In summary, the authors believe, that investing in the professional development of biology teachers is an investment in the future of education. It ensures high-quality teaching, promotes scientific progress, and contributes to the development of society as a whole.

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