

---

---

**Annotations and self-assessment of the contributions to the scientific works  
of chief assistant Antoanaeta Anastasova Angelacheva, PhD  
for participation in a competition for the academic position of Associate  
Professor in the area of higher education 1. Pedagogical Sciences,  
professional field 1.3. Pedagogy of Teaching....  
(Methodology of Teaching Chemistry)**

The total number of publications so far is 59, of which: 2 monographs, 1 book, 48 articles in scientific journals and collections, 8 educational tools.

For participation in the competition for the academic position Associate Professor are presented: 1 habilitating work; 1 book based on a protected dissertation on the awarding of the PhD; 1 monograph not presented as basic habilitating work; 28 publications, of which 7 articles in journals included in the global referral and indexing system (of which 2 are in English, 2 are independent and 2 are first authors), 21 articles in unreferenced journals with scientific review or in edited collective volumes (of which 6 are in English, 20 are independent); 3 teaching tools (of which 2 are independent and 1 are first author).

The presented scientific production is of a theoretically applied nature. Research searches are in the direction of developing and improving the main components of the chemistry training process: learning objectives and expected results; learning content; technology – organizational forms, approaches, methods and means of training; evaluation of the results of the learning process.

The contributions of the scientific publications submitted for participation in the competition can be grouped into the following thematic areas:

- 1. Teaching chemical experiment**
- 2. Environmental education in teaching chemistry in secondary school**
- 3. Organisation and control of the chemistry training process**

The separation of these thematic areas is conditional, since a publication related to the teaching chemical experiment can also discuss its possibilities for achieving ecological education in chemistry training and for diagnosing students' cognitive results.

➤ **Annotations and contributions to scientific papers on thematic area  
1. Teaching chemical experiment**

In this direction, the participant in the competition has worked together with Assoc. Prof. Elena Gergova, PhD.

## Monograph

[publication № 1]

- **Angelacheva, A.** (2020). *Experiment and observation in teaching chemistry*. Plovdiv, Makros, p. 157, ISBN 978-954-561-503-0.

Chemistry is an experimental science and as such the role of the experiment in chemistry training has undeniable significance. The understanding of chemical knowledge and its understanding by students can only be successful through the widespread application of the chemical experiment in the learning process. This fact determines the fixing in the content of the State Educational Requirements for educational content and in the Curricula of the field of competence “Experiment, research and calculation”. The emphasis on the chemistry training experiment, which is set out in the state documents, undoubtedly shows the importance of the experimental method of activating students’ cognitive and creative abilities, mastering practical skills, shaping skills for self-employment.

The monograph is the result of years of research by the author and presents his views on the essence, place, role and importance of the learning experiment in chemistry training in secondary school.

In the first chapter of the monograph:

– An overview of different concepts of the essence of science and the peculiarities of scientific knowledge has been made.

– The most commonly cited definitions of literacy, scientific literacy, natural science literacy, chemical literacy, and chemical literacy are analyzed in the specialized literature. Common points of contact were sought between different definitions by comparing the components of literacy (knowledge, skills and abilities, attitude and behaviour, metascience).

– The indications of classification of methods of scientific knowledge proposed in the scientific literature are summarised. On this basis, a classification of scientific methods is made depending on the field of study. The more important characteristics of general, private scientific and specific methods of scientific knowledge are presented.

– Emphasis is placed on scientific experiment and scientific observation as leading methods of empirical knowledge. The essence and peculiarities of these methods, their structural components and the signs of their classification have been revealed.

In the second chapter of the monograph:

– Different definitions of the nature of training methods have been analysed as an important component of the learning process.

– The verbal, visual and practical methods of chemistry training are characterized – nature, advantages, disadvantages and requirements in their application.

In the third chapter of the monograph:

---

---

– They are compared, by selected signs, the scientific and educational chemical experiment.

– The definitions for the study chemical experiment, which are present in the methodological literature, have been analyzed. Its structure is based on the structure of the scientific experiment, taking into account the specifics of the learning and cognitive process.

– The functions of the learning chemical experiment are summarized, which are commented on in the methodological literature. In connection with the didactic functions of the learning chemical experiment, its role in the realization of the cognitive and educational purposes of chemistry training was revealed.

– Systematic requirements related to the methodology and technique of execution of experiments in chemistry lesson are systematized. These requirements stem from the specifics of chemistry as a natural science and as a subject of study.

– Forms have been drawn up to combine the teacher's word with the visibility of chemical demonstrations. The presented forms play an essential role in the successful conduct of the learning chemical experiment in the learning process.

– The signs present in the specialized literature are summarized for the classification of the learning chemical experiments. The more important characteristics of the two main types of learning chemistry – demonstration and laboratory experiment and the specific requirements for their application in chemistry training are presented. In addition to the demonstration and laboratory experiment, other types of learning chemical experiment are found in chemistry training. Their nature, advantages and disadvantages, and requirements for their use in the learning process are discussed.

– Emphasis is also placed on the role of the learning chemical experiment in solving experimental-logical tasks in chemistry. The ways of organizing the experiment in placing similar tasks in chemistry training have been revealed, depending on the degree of activity and autonomy of the students.

– Attention is also focused on the possibilities of the educational chemical experiment to enrich the ecological culture of adolescents.

– The choice of definition of monitoring as a method of chemistry training is justified. There are systematic factors for effective application of the method in the learning process, as well as signs of its classification and more important methodological requirements for its realization. An algorithm for conducting the monitoring in the training process has been proposed.

– The role of the learning chemical experiment in carrying out the research and problematic approach in chemistry training has been revealed.

In the fourth chapter of the monograph:

– A methodology for preparing teachers for the application of the learning experiment in chemistry training has been developed.

– Cognitive models for experimental study of chemical objects in the conditions of the higher school are constructed with a view to forming natural science literacy of students – future chemistry teachers.

– Statistical processing and analysis of the results of a pedagogical experiment was carried out to establish the effectiveness of the methodology created. The data show that the use of research-based learning succeeds in achieving goals related to the formation of natural science literacy of students – future chemistry teachers.

### **Scientific publications on the thematic direction**

[publication № 11]

• **Angelacheva, A.** (2021). Possibilities of the inquiry-based approach for formation of the key competences in secondary school chemistry education. *Natural Science and Advanced Technology Education*, 30(1), 79-97, ISSN 2738-7135, Abstracting/Indexing: Chemical Abstracts (1998-), Google Scholar (2005-), EBSCOhost (2012-), CEEOL (2017-), Science Index (2019-).

The research approach in science training is mainly a means of forming and developing key knowledge, skills and relationships in students. Among the eight equal key competences are skills to support sustainable development and a healthy lifestyle. They are related to mastering ecological knowledge, forming skills for environmental protection and healthy lifestyle, building value relationships in adolescents.

The article presents an attempt to use the research approach in training in the profiled chemistry training to enrich the system of knowledge, skills and relations related to environmental protection.

– For the implementation of the research approach in the profiled chemistry preparation in 11<sup>th</sup> grade. The class has developed a laboratory practical for the preparation and examination of soil samples.

– The competences, as expected outcomes, of the application of the practicum in the process of learning chemistry – knowledge, skills and attitudes are defined.

– Sample didactic structures of laboratory exercises included in the workshop are developed.

– A criterion-referenced test “Soil and its protection from pollution” was designed to diagnose the cognitive performance of the students in the groups studied.

– Statistically processed results of the conducted diagnostic study are presented to establish the appropriateness of the constructed laboratory practice, concerning the enrichment of the system of ecological knowledge and skills and value attitudes of students towards the environment, i.e. for the development of their health-ecological competencies. The data show that the developed laboratory

practice creates good conditions for adolescents to acquire meaningful environmental knowledge, form skills for their application in different cognitive situations and build a value attitude towards the environment. This is a motive for improving the proposed laboratory practice and for continuing research in this direction, since the formation of key competencies is a continuous process and requires the application of different organizational forms, methods and means in the training process.

[publication № 4]

- **Angelacheva, A.** (2016). Assessment of the qualities of teaching experiments which illustrate the greenhouse effect. *Chemistry: Bulgarian Journal of Science Education*, 23(3), 415-427, ISSN 0861-9255, Abstracting/Indexing: SCOPUS 2006 – 2017.

The paper is a continuation of other work (see publication № 24, Angelacheva, 2013) and as such presents the development and refinement of the developed chemical experiments illustrating one of the global environmental problems – the intensification of the greenhouse effect on the Earth.

– The qualities of the learning experiences were examined by expert evaluation and in a representative sample of students in 9<sup>th</sup> grade in the conditions of specially organized experimental training.

– In order to establish the impact of the two organized learning options on the cognitive performance of the students, a didactic test “Greenhouse Effect” was created according to the selected criteria and indicators.

– The results of testing in the experimental groups of students were processed by mathematical-statistical methods. The data show that the developed learning experiments create good conditions for enriching students' environmental awareness and can be effectively used in the process of chemistry education.

[publication № 24]

- **Angelacheva, A.** (2013). Teaching experiments illustrating the greenhouse effect. *Scientific research of the Union of Scientists in Bulgaria – Plovdiv*, series C, Technology and technology, vol. XVI, Plovdiv, 115-119, ISSN 1311-9192.

To enrich the ecological culture of students, the possibilities of both the curricular content of natural science subjects and the system of organizational forms, methods and means of education can be used. A leading method in the process of chemistry education is the learning experiment, which allows direct observation and study of objects in the environment. It can be used to enhance students' environmental literacy by introducing them to the effects of chemicals on the environment and methods of protecting and restoring it.

– The paper presents some of the developed teaching experiments that illustrate the causes of the Earth's increasing greenhouse effect, and can be used

to illustrate the process of teaching chemistry in relation to enriching students' environmental awareness.

– For each of the experiments a worksheet is created, which reflects the methodological sequence of the experiments – the purpose of the experiment, place in the chemistry curriculum, substances and materials needed, experimental setup, observations and reflections on the experiment, conclusions.

– The qualities of the proposed teaching experiments were investigated by expert evaluation performed by students – future chemistry teachers. They perform the experiments in the exercises of the course Methodology and Technique of Educational Experiment in Chemistry.

– To assess the quality of the experiments, indicators related to their methodological and technical characteristics were developed.

– The data from the expert assessment are subjected to statistical analysis. As a result of the proposed trials, only those of very good or excellent quality have been implemented in pedagogical practice. The remaining trials were reworked or eliminated.

– The effectiveness of the developed experiments in enhancing students' environmental literacy has been proven through additional pedagogical research, the results of which are presented in another publication (see publication № 4, Angelacheva, 2016).

[publication № 25]

• **25. Angelacheva, A.** (2013). The teaching experiment in chemistry and the problem of smoking. *Journal of International Scientific Publications: Educational Alternatives*, vol. 11, part 1, 12-25, ISSN 1313-2571, Abstracting/Indexing: Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

Smoking is the most prevalent drug addiction worldwide, affecting people from all walks of life and across age groups. Therefore, it is necessary to use the possibilities of both state bodies, mass media and education to make people aware of the negative consequences of cigarette smoke on the human body, to build a responsible attitude towards their own health and the health of others.

This article presents the results of a diagnostic study on the role of a chemistry learning experiment in enriching students' knowledge, skills and attitudes about smoking.

– Selected and developed: chemical experiments to prove the presence of harmful substances in cigarette smoke; chemical experiments that illustrate the effects of cigarette smoke on living organisms.

– Information on the components of cigarette smoke and their physiological effects is systematized and discussed in the course of the experimental work.

– A criterion-referenced test, Smoking and Health, was developed and used to diagnose students' cognitive performance, focusing on their knowledge of smoking.

– A questionnaire was created to determine the students' attitudes towards the issue at hand.

– Statistical analysis of the results of the pedagogical experiment was performed. The data confirm the appropriateness of the developed chemical experiments to enrich the health and environmental awareness of the students.

– The proposed didactic materials (chemical experiments to demonstrate toxic substances in tobacco and in tobacco smoke and teaching texts with information on the physiological action of tobacco smoke components) can be directly used in chemistry teaching practice.

[publication № 26]

• **26.** Gergova, E. & **Angelacheva, A.** (2013). Place of school chemical experiment in the cognitive models for studying oxides. *Scientific research of the Union of Scientists in Bulgaria – Plovdiv*, series B, Natural Sciences and Humanities, vol. XV, Plovdiv, 80-85, ISSN 1311-9192.

The chemistry curriculum can be viewed as a minimized model of chemical science whose primary method of inquiry is experiment. It carries essential information about the objects studied – substances and chemical reactions. In this aspect, an important task of the training of students – future chemistry teachers, is both mastering the theoretical dimensions of the cognitive significance and the educational potential of the teaching chemistry experiment, and forming the skills for its successful implementation in the classroom.

The study is a continuation of the model for organizing the students' exercises in the discipline “Methodology and Technique of Educational Experiment in Chemistry” reported in another article (see publication № 8, Gergova & Angelacheva, 2011).

– This paper presents the developed cognitive models for the experimental study of oxides (basic, acidic and amphoteric) at different cognitive levels – empirical level, subject “Man and Nature” in 5<sup>th</sup> and 6<sup>th</sup> grade; updated atomic-molecular level, subject “Chemistry and Environmental Protection” in 7<sup>th</sup> and 8<sup>th</sup> grade; contemporary cognitive level, subject “Chemistry and Environmental Protection” in 10<sup>th</sup> grade.

– The role of chemical experiment in the problem-based study of oxides is elucidated; in revealing the essential features of the concept of oxide and its development in the school chemistry course.

– The created research models can be successfully used as didactic materials in chemistry teaching practice. Their application in the exercises of “Methodology and Technique of the Chemistry Experiment” enriches the system of knowledge and skills of the students – future chemistry teachers for successful development of the cognitive possibilities of the chemical experiment in the chemistry lesson

---

---

and for linking the experimental results with the theoretical knowledge, an important component of which are the chemical concepts.

[publication № 27]

• **Angelacheva, A.** (2012). Chemical experiments with metals from IA и IIA groups of periodic table. *Scientific publications from the Jubilee National Scientific Conference with international participation "Traditions, directions, challenges"*, vol. II, part I, Natural Sciences, Mathematics and Informatics, Plovdiv University, affiliate Smolian, 186-194, ISBN 978-954-8767-42-2.

Considering the cognitive value of chemical experiments for the realization of a meaningful educational process, ways are being sought to optimize both their number in the lesson and their methodological setting and the rules for their safe implementation.

– With the present work, the author aims to enrich the described in the literature versions of teaching chemical experiments related to the determination of physical and chemical properties of simple substances of the elements of groups IA and IIA of the periodic system.

– Variants of teaching chemistry experiments are selected and developed, which can be used to illustrate the teaching of chemistry in 7<sup>th</sup> and 8<sup>th</sup> grade, as well as in the training of students – future teachers of chemistry, in the exercises in the discipline “Methodology and technique of the teaching experiment in chemistry”.

– A significant reason for depriving the cognitive process of chemistry of valuable chemical experiments for its organization is related to the fact that many of them are dangerous to perform.

– In this regard, the description of the proposed experiments is systematically accompanied by rules for their safe performance and first aid measures in case of possible injury.

[publication № 8]

• **Gergova, E. & Angelacheva, A.** (2011). Model for organizing and conducting the exercises according to the methodology and technique of the learning chemical experiment. *Chemistry* 20(3), 207-219, ISSN 0861-9255, Abstracting/Indexing: SCOPUS 2006 – 2017.

The course on “Methodology and Technique of Educational Chemistry Experiment” is particularly significant in preparing chemistry students for the realization of the teaching profession. The aim of the course is to familiarize students with the place and role of the chemistry experiment in chemistry education, with the methodology of its inclusion in the lesson; to acquire theoretical knowledge and practical skills for selecting and performing chemical experiments in school settings.



– A model for organizing and conducting the exercises on “Methodology and technique of chemical experiment” is developed. The structural elements of the model and the interrelationships in which they function are identified.

– The model is specified for the topics of the discipline “Methodology and Technique of Educational Chemical Experiment”, related to the discussion of the properties of metals of the main and secondary groups of the periodic system.

– Algorithms are proposed for the problematic consideration of metals at three theoretical levels – before studying the periodic law and the periodic system; after their study; at a contemporary theoretical level.

– The functions of the chemical experiment in the different stages of the problem study of metals are outlined.

– The established methodology for the organization of classes in the discipline “Methodology and Technique of the Educational Chemical Experiment” ensures the mastery of knowledge and skills by students for the full development of the educational and educational functions of the chemical experiment as an important method of teaching chemistry.

– It makes chemical experiments, which are included in the experimental activities of students, an integral part of the organization of the process of learning chemistry in secondary school.

– Constructed models for the experimental study of chemical objects are useful not only for enriching students’ knowledge of specific facts, but also for mastering cognitive models for the study of simple substances, from which important generalizations are reached.

– At the same time, there are opportunities to enrich the models themselves in terms of deepening students' theoretical knowledge and transferring and using them in new cognitive situations, for example in the study of simple non-metallic substances.

[publication № 9]

• Gergova, E. & **Angelacheva, A.** (2011). The chemical experiment – the main method in the problematic study of the theory of electrolyte dissociation. *Chemistry* 20(1), 57-66, ISSN 0861-9255, Abstracting/Indexing: SCOPUS 2006 – 2017.

The chemical experiment is an important element in the application of the problem-based approach and finds concrete expression in the types of problem situations developed (cognitive, organizational-production, evaluative).

– In this paper, the essential features of the concepts related to the electrolytic dissociation theory are highlighted.

– The main and private content problems in its study in secondary school are highlighted.

– The place and role of specific chemical experiments in solving the defined problems and in modeling the content of concepts related to electrolytic dissociation theory is defined.

– The results of the work can be used: (a) by students in the exercises in the discipline “Methodology and technique of the chemical experiment” in the implementation of methodological analysis of chemical experiments related to the clarification of the essence, the basic premises and the consequences of the theory of electrolytic dissociation; (b) by chemistry teachers to support students’ cognitive learning in problem-based learning of electrolyte dissociation theory.

### **Learning tools on the thematic area**

[publication № 31]

• **Angelacheva, A.** (2014). *Chemistry – observations and experiments. Module non-metals*. Plovdiv, Plovdiv University Press, p. 148, ISBN 978-954-423-918-3.

The textbook offers ideas (cognitive orientations) for the construction of the content of the module “Non-metals”, according to a developed curriculum for free elective training “Chemistry – observations and experiments” (8<sup>th</sup> and 9<sup>th</sup> grade). It aims to expose students to chemistry as an attractive natural science in which the leading methods are observation and chemical experiment.

The development of cognitive orientations is carried out in the following interrelated directions:

– Sample content plan. Through a new structuring of the nonmetals curriculum, a variety of learning activities are planned, related to the transfer of mastered knowledge in different cognitive situations, awareness of the importance of chemical knowledge in solving environmental problems.

– Logical-psychological structure following the main stages of the cognitive process in problem solving situations. It is presented schematically and is subordinated to the requirements for didactic modelling of chemical knowledge under the conditions of the problem-research approach.

– Methodological structure, which reflects the methods and means for the implementation of the didactic structure of the topics of the module. The methodological structure includes a system of set up chemistry problems and chemistry experiments.

– Structure of student interaction based on Dr. Spencer Kagan’s cooperative learning approach. The approach is implemented by cooperating individual student activities while working in a group according to defined interaction patterns. The proposed communicative structures allow the application of a variety of forms, methods and means of teaching, and learning techniques for students.

Cognitive landmarks are not a ready-made prototype or a regulated prescription, but outline a field for creative freedom. They are interpreted by the teacher in the study of specific topics of the curriculum content in the direction of creating conditions for the formation of a system of chemical knowledge, intellectual and specific-chemical skills and values towards the environment.

[publication № 32]

• **Angelacheva, A. & Stefanova, J. (2010).** *Methodology and technique of the learning chemical experiment. Part II.* Plovdiv, Plovdiv University Press, p. 111, ISBN 978-954-423-580-2.

The textbook was compiled in order to support the exercises in the discipline of the same name, included in the curricula of the Bachelor's degree courses "Biology and Chemistry", "Chemistry and English", "Science education in the lower secondary stage of school education". Chapters VII, VIII, IX, X, XI, XII, XIII and XIV of the manual were written by chief assistant A. Angelacheva.

This textbook discusses the methodology and technique of setting up teaching chemistry experiments in the study of organics in secondary school chemistry. My personal contributions to the development of these chapters of the guide are:

– For each of the topics related to the study of specific organic substances, its place and importance in the global structure of the chemistry curriculum is outlined.

– Learning objectives are defined that can be realized with the participation of the learning chemical experiment when discussing the composition, structure, properties of different organic substances.

– The main methodological problems in the study of organic substances and the role of the chemical experiment in their solution are outlined.

– Particular attention is paid to the physiological action of the organic substances under consideration and first aid measures in case of exposure.

– The technique of performing chemical experiments in revealing the physical and chemical properties of organic substances is described in detail.

– At the end of each chapter, ecological highlights are given on the distribution of the organic substances studied in nature, the sources of environmental pollution by these substances and measures to limit their release into the environment.

– Appropriate experimental tasks are selected and composed for each topic.

[publication № 33]

• **Angelacheva, A. (2006).** *Methodology and technique of the learning chemical experiment. Part I.* Plovdiv, Plovdiv University Press, p. 175, ISBN 978-954-423-345-7.

The manual is intended for the students of the Faculty of Chemistry and Biology of the Paisii Hilendarski University, who study the discipline "Methodology and Technique of Experiments in Chemistry". Chemistry teachers could also make effective use of the textbook in teaching and supervising content related to the study of inorganic substances in secondary school.

– The methodology of setting up teaching experiments in considering the properties of metals and non-metals and their chemical compounds is revealed, relating to: determining the purpose of each experiment, the type of experiment

used and the format for combining the experiment with the talk, describing the experimental set-up and the observations and reflections on the experiment, and drawing conclusions based on the experiment.

– The experimental technique was improved with the proposed experimental setups.

– Systematization is information about: the physiological action of substances that are the subject of chemical experiments; the rules for safe work in their implementation; the means of limiting the release of harmful substances into the environment during the experiments; first aid actions in case of a strike; the distribution of substances in nature; natural and industrial sources of environmental pollution by inorganic substances.

– A variety of constructive, technological, entertaining and ecological experiments, as well as experimental and logical tasks are developed to stimulate the creative abilities of students – future chemistry teachers.

➤ **Annotations and contributions to scientific papers on thematic area 2. Environmental education in secondary school chemistry education**

In this field the participant in the competition worked together with Assoc. Prof. Elena Gergova, PhD.

**A published book based on a defended dissertation for the award of the educational and scientific degree PhD**

[publication № 3]

• **Angelacheva, A.** (2019). *Modern aspects of environmental education in chemistry education in secondary school*. Plovdiv, Plovdiv University Press, p. 110, ISBN 978-619-202-527-4.

The problem of implementing environmental education in the process of chemistry education is developed on the basis of theoretical research and pedagogical experiment. An attempt is made to solve this problem by analyzing understandings of the nature of environmental education in the fields of pedagogy, psychology, and teaching methods. This work adds new emphases to the theory and practice of chemistry and environmental education in the following areas:

– A didactic model for the implementation of environmental education in the process of chemistry education is developed and theoretically justified. In the first chapter of the book the model is developed in its four main components – objectives and expected results, learning content, technology for organizing learning activities and a system for controlling the learning process.

– The objectives of chemistry and environmental education are updated in terms of the system of environmental knowledge and skills, and students' value orientations towards the environment. The formulated objectives can be used as a

---

---

basis for setting learning objectives for the study of the factual sections of the chemistry curriculum.

– Based on the content and operational chemical knowledge, operationalized goal models are built with an emphasis on the system of knowledge, skills and attitudes related to environmental protection. They can serve as a guideline for planning the organization of the learning process.

– The guidelines for the use of chemistry and environmental education content for the implementation of environmental education are outlined. The potential of facts and concepts to enhance students' environmental literacy by incorporating ecologically oriented attributes into the content of these components is demonstrated, as well as the potential of theoretical knowledge in environmental problem solving.

– Through a theoretical analysis, the components of technology (approaches, forms, methods and means) for the implementation of environmental education in the process of chemistry and environmental education, and the interrelations in which they are located. The choice of the teaching chemistry experiment and the discussion as basic methods in technology is justified. In connection with the development of the ecological functions of the teaching chemical experiment, the methodological guidelines for the conduct, analysis and reporting of the chemical experiments carried out have been enriched with a focus on environmental issues. Opportunities for reducing or eliminating the release of harmful substances into the environment when performing chemical experiments are outlined.

– Criteria for selection and composition of chemistry teaching tasks with ecological orientation are developed. In accordance with the defined criteria, a new task classification is proposed. It allows the design of specific tasks with potential opportunities for enriching the environmental culture of students.

– The methodology for the preparation and implementation of seminars and role-plays as organizational forms for the implementation of environmental education in the process of chemistry education is specified.

– In the second chapter of the book, the model developed for the implementation of environmental education in the process of chemistry education is applied to the section "Group VA of the periodic system".

– A rich didactic material has been created (teaching tasks and chemical experiments with ecological orientation, methodological versions of seminars on ecological topics, criterion tests, etc.), which can be used immediately in pedagogical practice for various didactic purposes.

– The ideas presented in the book for the implementation of environmental education in the process of teaching chemistry have theoretical and practical significance for the preparation of students in the disciplines Methodology of teaching chemistry, Environmental education in teaching chemistry (elective course), Teaching tasks in teaching chemistry (elective course).

### Scientific publications on the thematic area

[publication № 13]

• **Angelacheva, A.** (2019). Educational content for metals of periods 4<sup>th</sup> -6<sup>th</sup> of the periodic table – a factor for enrichment students' ecological culture. *Management and education*, vol. 15(3), Burgas, University „Prof. Dr Assen Zlatarov“, 185-193, ISSN 13126121, Abstracting/Indexing: EBSCO.

The teaching content on the metals of the 4<sup>th</sup> -6<sup>th</sup> periods of the periodic system is conducive to revealing the relationship: chemistry – environment, but it does not sufficiently highlight the environmental issues related to the production, properties and use of simple substances and chemical compounds of the 4<sup>th</sup> -6<sup>th</sup> periods.

– In this regard, an analysis of the main components of the content (facts, concepts, laws, laws and theories) is carried out in order to outline their potential for enriching the students' environmental culture.

– On this basis, a structural-logical version of the curriculum content for metals from 4<sup>th</sup> -6<sup>th</sup> periods by changing the emphasis of its main components, in a volume corresponding to the requirements in the curriculum for 10<sup>th</sup> grade.

– The curriculum material is designed as an integral centre of information about man, society, nature and the interaction between them, with a stronger emphasis on: (a) the distribution of the elements of 4<sup>th</sup> -6<sup>th</sup> periods in nature; (b) their biological significance or toxic effect; (c) the environmental problems that arise in the extraction of the metals from 4<sup>th</sup> -6<sup>th</sup> periods – the sources of environmental pollution, the impact of pollutants on the environment, etc.; (d) the environmental problems associated with the use of the simple substances and chemical compounds of the elements 4<sup>th</sup> -6<sup>th</sup> periods in industry, in agriculture; (e) the means of limiting the input of environmentally harmful substances of the elements 4<sup>th</sup> -6<sup>th</sup> periods or for their disposal.

– The effectiveness of the developed version of the curriculum has been proven through a pedagogical experiment. The results show an increase in students' learning with a focus on their environmental awareness within the curriculum content under consideration.

[publication № 15]

• **Angelacheva, A.** (2018). Study of the effectiveness of a seminar “Chemical elements of the VI-A group of the Periodic table and environmental protection” (8<sup>th</sup> grade). *Journal of International Scientific Publications: Educational Alternatives*, vol. 16, 205-214, ISSN 1314-7277, Abstracting/Indexing: Russian Science Citation Index, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

The topicality of the problem of optimizing the process of chemistry education, as well as the possibilities of the seminars for the development of cognitive interests of students, for increasing independence in the formation of a

system of knowledge, skills and attitudes related to environmental protection, determine the direction of the work.

– On the basis of a theoretical analysis of the nature of seminar classes, the methodology for the preparation and implementation of a seminar class to summarize and systematize students' knowledge and skills is specified.

– A methodological version of the summarizing seminar “Chemical elements of VI-A group and environmental protection” 8<sup>th</sup> grade. The proposed specific methodological solutions are useful for pedagogical practice in chemistry when studying the section “Nonmetals. Group VI-A chemical elements” in 8<sup>th</sup> grade, which with its practical-applied orientation is particularly suitable for the application of non-traditional forms of training organization.

– The constructed summarizing seminar is included in the developed version of didactic technology for enrichment of students' ecological culture in Chemistry and Environmental Protection 8<sup>th</sup> grade.

– Statistically processed results of a pedagogical experiment conducted to study the effectiveness of the modeled lesson for enriching the environmental culture of students in the process of chemistry education are presented. The data proves its relevance and positive impact on the productivity of chemistry learning activities with emphasis on students' environmental preparation.

[publication № 16]

• **Angelacheva, A.** (2018). Correlation dependences between ecological knowledge and attitudes of students towards the environment in secondary school chemistry education. *Management and education*, vol. 14(3), Burgas, University „Prof. Dr Assen Zlatarov“, 89-96, ISSN 13126121, Abstracting/Indexing: EBSCO.

The review of the methodological literature shows the existence of theoretical and theoretical-empirical studies that envision different didactic variables for the purposeful formation and enrichment of students' ecological culture in the teaching of natural science subjects. However, aside from the authors' research interest remains the problem of investigating correlations between the main components of environmental culture, environmental knowledge and skills, and students' values towards the environment.

– The paper presents an experimental study related to the presence/absence of correlational consistency between environmental knowledge and students' values orientations towards the environment in the process of learning chemistry 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> grade.

– The overall pedagogical study has the character of a longitudinal, longitudinal study. The bibliographic reference shows that such studies are rare in the practice of school chemistry education.

– The results of a pedagogical experiment with the inclusion of the developed educational technology for enriching the ecological culture of students are presented.

– The choice of criteria and indicators for the diagnosis of students' environmental culture is justified. On the basis of the selected criteria and indicators, three criterion tests "Group VIA of the periodic system and environmental protection" (8<sup>th</sup> grade), "Group VA of the periodic system and environmental protection" (9<sup>th</sup> grade) and "Group B of the periodic system and environmental protection" (10<sup>th</sup> grade) were developed.

– A correlation analysis of the test results was performed. Evidence suggests that traditional education, in which environmental culture is not the subject of purposeful activation and development, does not have a significant impact on students' environmental knowledge and values, both cognitively and personally.

– The empirical data show that the application of the developed educational technology in chemistry education (grades 8<sup>th</sup>-10<sup>th</sup>) has a positive impact on the formation and enrichment of students' environmental culture. In all three years of the pedagogical study, the experimental group of students showed a significant positive correlation between environmental knowledge and students' values towards the environment.

– It can be argued that the developed forms, methods and means of training for the implementation of the technological option create good conditions for the mastery of meaningful environmental knowledge by students.

[publication № 20]

• **Angelacheva, A.** (2017). Possibilities of learning organic chemistry tasks for increasing the environmental training of students. *Scientific researches of the Union of Scientists in Bulgaria – Plovdiv*, series C, Technique and technology, vol. XIV, Plovdiv, 171-176, ISSN 1311-9419.

The review of the specialized literature shows that some aspects of the chemistry curriculum content and the methodology for its mastery have been studied in relation to enriching the environmental culture of students mainly in the teaching of inorganic chemistry. Untapped are the opportunities in the substantive aspect of organic chemistry, its place in the system of chemical knowledge with an ecological orientation, its role in the development of students' ecological training on a broader intrasubject and intersubject basis.

– In this regard, an analysis of the organic chemistry curriculum content is carried out and content aspects are identified that can be used to enrich students' environmental awareness. Turning these content aspects into an opportunity to enhance students' environmental literacy can be done by using tasks with environmental content.

– To support the process of designing and selecting such problems, criteria for classifying organic chemistry problems with an ecological focus are derived.

– Specific examples are provided for each group of tasks. The place of the developed organic chemistry problems with environmental content in the different stages of the chemistry lesson is determined.



– The created didactic materials were tested in a specially organized experimental study. The statistical processing of the results obtained by him shows that the application of the system of tasks with ecological content creates good conditions for increasing the ecological training of students.

[publication № 21]

• **Angelacheva, A.** (2016). Results of the test approbation “Drinking water” in teaching chemistry (10<sup>th</sup>) grade. *Journal of International Scientific Publications: Educational Alternatives*, vol. 14, 437-446, ISSN 1314-7277, Abstracting/Indexing: Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

The hydrosphere, the watery shell of planet Earth, covers 3/4 of its surface. But a small fraction of the total mass of the hydrosphere is usable by humans. Solving the problem of meeting human needs for drinking water is closely linked to ensuring its quality.

– A Drinking Water Test was constructed and used as the main diagnostic tool for the effectiveness of the developed Drinking Water Analysis laboratory lesson (see publication № 23, Angelacheva, 2014). The test records the system of knowledge, skills and attitudes of students towards the problems of ensuring the quality of drinking water, the protection of natural water, in the learning and cognitive activity 10<sup>th</sup> grade.

– The qualities of the test items were investigated in two aspects: determining the difficulty and discriminative power of the test items; establishing the reliability of the subtests and of the test as a whole.

– The results of the statistical processing of the test data demonstrate the ability of the test item system to serve as a qualitative tool for measuring and assessing the learning achievements of the students in the experimental study. The main characteristics of the test items meet the requirements of didactic tests described in the pedagogical literature.

[publication № 23]

• **Angelacheva, A.** (2014). Practical lesson “Analysis of drinking water” in teaching “Chemistry and environmental protection” (in the 10<sup>th</sup> grade). *Journal of International Scientific Publications: Educational Alternatives*, vol. 12, 166-176, ISSN 1313-2571, Abstracting/Indexing: Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

To enrich the knowledge of adolescents about organoleptic and physicochemical indicators of drinking water quality, skills for their experimental determination and values on the problem of water conservation in nature, a laboratory lesson “Drinking water analysis” was developed.

– The methodological development of the lesson is presented: the aim of the lesson and the objectives of the lesson are defined in terms of the knowledge, skills and values of the students; questions and tasks are defined for students' prior preparation; chemical experiments are selected to establish the physical properties and chemical composition of drinking water samples.

– Experimental training was conducted to prove the appropriateness of the developed lesson in chemistry and environmental education 10<sup>th</sup> grade (specialized training).

– The empirical material obtained in the course of the pedagogical experiment gives grounds to claim that the developed laboratory lesson is an effective form of organizing chemistry education. It has a positive impact on the development of students' environmental knowledge and skills; stimulates their transfer in different cognitive situations; encourages critical thinking and an appreciative attitude towards the environment.

[publication № 5]

• **Angelacheva, A.** & Kamarska, K. (2014). Knowledge of and attitudes towards water in 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> grade students. *Chemistry: Bulgarian Journal of Science Education*, 23(3), 333-339, ISSN 0861-9255, Abstracting/Indexing: SCOPUS 2006 – 2017.

Water is the most common liquid substance on Earth. The knowledge about it and the related value attitudes are components of students' environmental culture, which is formed and enriched through the teaching of natural science subjects.

– The article presents a diagnostic study of the system of knowledge and value attitudes to the substance water in the minds of students in 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> grade.

– Through the analysis of the curricula “Man and Nature” (5<sup>th</sup> and 6<sup>th</sup> grades) and “Chemistry and Environmental Protection” (7<sup>th</sup> grade), the expected results (terms, concepts) related to the substance water are defined.

– The content of the posters and multimedia presentations developed by the students for participation in the competition “March 22 – Water Day” (held two consecutive school years) was studied in terms of the absolute and relative frequency of occurrence of individual words, whole phrases and specific figures that refer to a given attribute to describe the substance water. The frequency of appearance of an indicator in the text is considered to be a measure of its significance.

– The content analysis method was used to look for a correspondence between the curricular learning objectives (students' knowledge and values towards water) and the students' cognitive outcomes reflected in the posters and multimedia presentations they created. The comparison guides the productivity of learning concepts related to water knowledge.

– The statistical analysis of the results of the study shows that the teaching of the relevant subjects creates a good basis for the integration of knowledge and values in the minds of the students studied towards the substance water.

[publication № 6]

• **Angelacheva, A.** (2014). Diagnosis of students' environmental culture in the study of VI-A group of Periodic table in 8<sup>th</sup> grade. *Chemistry: Bulgarian Journal of Science Education*, 23(2), 192-207, ISSN 0861-9255, Abstracting/Indexing: SCOPUS 2006 – 2017.

In another publication (see publication №. 7, Angelacheva & Gergova, 2013) the cognitive objectives, structure and content of a criterion-referenced test “Group VIA of the periodic system and environmental protection”, based on the compulsory curriculum content of Chemistry and Environmental Protection 8<sup>th</sup> grade. In order for a constructed test to serve as an effective diagnostic of students' environmental culture, it must have good statistical properties.

This paper presents the results of the statistical study of the properties of the criterion test “VIA group of the periodic system and environmental protection”.

– The analysis of the test tasks was carried out in the following aspects: (a) a priori analysis – implemented by the method of expert evaluation; (b) a posteriori analysis – by statistical processing of the test results in a representative sample of students in 8<sup>th</sup> grade.

– Empirical data from the a priori analysis were processed using mathematical and statistical methods. The results show that the test has good statistical characteristics and can serve as an effective diagnostic of students' environmental culture.

– The test was used as the main diagnostic tool in the organized experimental training, which aimed to verify the appropriateness of the developed didactic technology for enriching the ecological culture of students in the study of the VIA group of the periodic system in 8<sup>th</sup> grade.

– Similar diagnostic tools can be created within other topics of the chemistry curriculum, since the targeted formation and diagnosis of students' environmental culture, which is an integral part of the general culture of the individual, should be a special task of chemistry education at school.

[publication № 7]

• **Angelacheva, A. & Gergova, E.** (2013). Didactic tools for the formation and diagnosis of students' environmental culture in chemistry education. *Chemistry: Bulgarian Journal of Science Education*, 22(4), 532-543, ISSN 0861-9255, Abstracting/Indexing: SCOPUS 2006 – 2017.

Environmental tasks not only have diagnostic capabilities, but also empirically proven positive effects on the formation of environmental culture in students.

– In accordance with the defined criteria for the selection and composition of chemistry teaching tasks with an ecological focus, a classification of these tasks is proposed. It allows the design of specific tasks with potential opportunities for both the formation of environmental culture in students and its diagnosis.

– The choice of criteria and indicators for diagnosis of the system of ecological knowledge and values of students towards the environment is justified.

– The selected criteria and indicators, as well as the proposed classification of tasks with environmental orientation are the basis of the created version of the criterion test “Group VIA of the periodic system and environmental protection”. Its cognitive aims, structure and content are presented.

[publication № 10]

• Gergova, E. & **Angelacheva, A.** (2008). Technology for the implementation of environmental education in the process of teaching chemistry. *Chemistry* 17(1), 16-24, ISSN 0861-9255, Abstracting/Indexing: SCOPUS 2006 – 2017.

The effectiveness of any technology in the field of education depends on the chosen set of “tools” – approaches, organizational forms, methods and means of learning.

– The article justifies the choice of components of the technology to ensure its functioning in the process of teaching chemistry in order to implement environmental education.

– The foundation that could encompass the content and functions of the other structural components and also optimise their interaction is the problem-research approach. Its inclusion in the technology is justified in relation to the results of its application in the learning process, related to the achievement of high levels of cognitive activity and independence of students.

– On the basis of the place and functions of the chemical experiment in solving cognitive problem situations, as defined in the methodological literature, it is chosen as the leading method in technology.

– The methodological guidelines for performing and discussing the chemical experiments performed in an ecological aspect are enriched. Some ways of limiting the introduction of harmful substances into the environment during experiments in the process of chemistry education are also identified.

– The inclusion of discussion as an additional method of learning is motivated. In technology, it supports the disclosure of: the ecological aspects of the learning content; the ecological potential of chemistry teaching experiments, didactic tools and experimental lessons.

– A classification of ecologically oriented chemistry learning tasks is proposed, which can be used in the design of specific tasks to enhance students’ ecological competence.

In each case of its functioning, the technology provides the possibility of simultaneous deployment of invariance and variation, which gives it the qualities of a relatively stable and at the same time dynamic, open system.

[publication № 28]

• **Angelacheva, A.** (2008). Learning objectives in chemistry and environmental education. *Journal Ecology & Safety. International Scientific Publications*, vol. 2, Part 2, 164-175, ISSN 1313-2563, Abstracting/Indexing: ECOLEX, Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

Goals are a leading component of the learning process, as a clearly understood goal is a prerequisite for the choice of learning content, forms, methods and means for its implementation.

The paper analyses the Chemistry and Environmental Science curricula. It shows that the objectives presented in the Curricula do not sufficiently reflect the changes stated with the introduction of the subject “Chemistry and Environmental Protection” as part of the cultural-educational area “Natural Sciences and Ecology”. A careful review of the curriculum objectives does not reveal any related to the acquisition of environmental knowledge and skills and the formation of values towards the environment. Similar is the result of the analysis of the objectives defined in the chemistry and environmental protection teacher books of the authors whose textbooks are used for chemistry education, which does not reveal the presence of environmentally oriented objectives, although the chemistry curriculum provides good opportunities for this.

– In this regard, the objectives of chemistry education in ecological aspect are formulated.

– Theoretical models of learning objectives in chemistry with emphasis on environmental knowledge, environmental problem-solving skills and values orientations towards the environment have been created for the study of the section "Chemistry of Elements and their Compounds" in 9. Class.

– The theoretical models developed allow for greater specificity in the formulation of learning objectives in the study of the factual sections of the chemistry curriculum. At the same time, these models can be used as a basis for the selection of approaches, organizational forms, methods and means of training.

[publication № 29]

• **Angelacheva, A.** (2007). On concepts related to environmental education. *Ecology. Scientific Articles 2007*. vol. 1, 354-361, ISBN 954-9368-16-5, Abstracting/Indexing: ECOLEX, Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

A thorough review of the psychological and pedagogical literature shows that understandings of the nature of environmental education are quite diverse. There are invariant positions in them, but there are also differences.

– On the basis of theoretical analysis of the literature, environmental education and its subordinate concepts – environmental culture, environmental consciousness and environmental behavior, are identified as the leading concept.

– For a more comprehensive disclosure of the content of the basic concept, the content of the scientific ecological concepts (the concepts that reflect the relationship between living organisms and their environment) nature, natural environment, natural resources, environment, pollution and environmental protection, etc., and of the general pedagogical concepts of education, training, upbringing is defined.

– The interrelationships between concepts related to environmental education are presented.

– A definition of environmental education is provided.

– The synthesis of a concept of the nature of environmental education through the analysis and interpretation of different conceptions serves as the basis for further research on the problem of implementing environmental education in the process of teaching chemistry.

[publication № 30]

• **Angelacheva, A.** (2006). Seminar classes in chemistry and environmental education. *Scientific Articles Ecology 2006*, Part 1, 172-185, ISBN 954-9368-16-5, Abstracting/Indexing: ECOLEX, Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

Along with the lesson as the main form of teaching, some non-traditional forms are also suitable for strengthening the environmental orientation of the chemistry teaching process.

– The article discusses the possibilities of seminar classes for the implementation of environmental education, as they greatly provide individualization of learning and contribute to the expression of personal inclinations and interests of students and the development of their creative abilities.

– The advantages of seminar classes as a form of organizing chemistry education in order to increase students' environmental awareness are systematized.

– On the basis of a theoretical analysis of the methodological literature, the main stages of the preliminary preparation of the seminars are defined.

– The stages in which the didactic structure of the seminars is reflected are also outlined. Emphasis is placed on the teacher's and students' activities in the distinct stages of the workshops.

– The classification of the seminar sessions in the context of the didactic problems to be solved is enriched.

– A model for organizing and conducting the seminar classes is proposed, which includes: class objectives; pre-preparation plan; preliminary study questions and tasks; list of references; monitoring sites and issues related to them; tasks to consolidate new knowledge.

– The model is concretized in the presented methodological development of a workshop for the acquisition of new knowledge on environmental topics.

[publication № 31]

• **Angelacheva, A.** (2006). Application of role-playing games for the implementation of environmental education in chemistry education. *Scientific publications from Jubilee National Scientific Conference with international participation "20 years Union of Scientists in Bulgaria branch Smolyan"*, Smolyan, 37-49, ISBN 978-954-8329-87-3.

To strengthen the ecological orientation of chemistry education, various organizational forms can be used – seminars, didactic games, etc. This article discusses the potential of role-playing games to help students acquire knowledge, skills and attitudes related to environmental protection.

– The advantages of organizing role-plays to enhance students' environmental learning in chemistry education are outlined.

– Based on the analysis of the literature, the main components of role-playing games and the stages in their implementation are systematized.

– To implement environmental education in the process of chemistry education, the following role-plays have been developed: a production meeting in a chemical plant; a production situation related to an accident in a chemical plant; a meeting of a scientific council to solve environmental problems; environmental hearing.

– One of the created role-playing games with ecological orientation is presented – the objectives of the game, the main actors and the scenario for the game are defined.

➤ **Annotations and contributions to scientific papers on thematic area  
3. Organization and control of the chemistry teaching process**

**A published monograph that is not presented as a major habilitation work**

[publication № 2]

• **Angelacheva, A.** (2020). *Organisational forms of chemistry teaching*. Plovdiv, Makros, p. 128, ISBN 978-954-561-513-9.

The problem of organizational forms of learning, as the essence and meaning, is fundamental in the research search for the development and

---

---

improvement of the learning process in chemistry. Form, as a kind of architecture of the learning process, affects all its components. This justifies the special attention that is paid to the problem at hand in didactic terms.

In the first chapter of the book:

– The author's view on the nature and types of organizational forms in the process of chemistry education is presented.

– The elements of the didactic, methodological and logical-psychological structure of the chemistry lesson are defined.

– The main stages in organizing a chemistry lesson are outlined. The activities of the teacher and the students in the different stages are described.

– The signs for the classification of chemistry lessons are summarized depending on: (a) the didactic objectives of the lesson; (b) the dominant method in the lesson.

– The macrostructure of different types of lessons used in chemistry education is presented.

– The structure and stages of some classroom and extracurricular forms of organization of chemistry education are defined.

In chapter two of the book:

– A model chemistry lesson plan-concept has been developed that can be used in the preparation and implementation of specific topics in the chemistry curriculum.

– Models for organizing an observation of a chemistry lesson and for analyzing an observed chemistry lesson are proposed, which can be applied in chemistry teaching practice.

– Methodological developments of different types of chemistry lessons have been created, which can be used in the teaching process for different didactic purposes. Of course, the generalized and theoretically informed experience presented should be applied creatively depending on the specific pedagogical situation.

### **Scientific publications on the thematic area**

[publication № 12]

• **Angelacheva, A.** (2020). A didactic test to determine students' learning in chemistry with emphasis on their natural science literacy. *Management and education*, vol. 16(3), Burgas, University „Prof. Dr Assen Zlatarov“, 22-29, ISSN 13126121, Abstracting/Indexing: EBSCO.

The article presents the diagnostic toolkit used to prove the appropriateness of the constructed methodology for experimental study of substances and chemical processes, with a view to building natural science literacy in students – future chemistry teachers.

– The main stages of test development are described (defining the purpose of the test, creating the test specification, developing the test items and the test as



a whole), the procedures for proving its qualities and the results of the statistical analysis of the expert evaluation of the test.

– The a priori analysis proves that the properties of the constructed test meet the basic requirements for didactic tests described in the literature. The developed version of the criterion-referenced test can effectively serve as a diagnostic tool for students' learning in chemistry with a focus on their science literacy.

[publication № 14]

• **Angelacheva, A.** (2019). Possibilities of didactic test for diagnostics of teaching results in the 6<sup>th</sup> grade, section “Substances and their properties”. *Scientific Researches of the Union of Scientists - Plovdiv, Series C, Technique and technology*, vol. XVII, Plovdiv, 181-187, ISSN 1311-9419.

[publication № 17]

• **Angelacheva, A.** (2018). Research on the cognitive performances of students in teaching “Man and nature” 5<sup>th</sup> grade (module Chemistry) – part II. *Scientific Researches of the Union of Scientists - Plovdiv, Series B, Natural Sciences and Humanities*, vol. XVIII, Plovdiv, 4-9, ISSN 1311-9192.

[publication № 18]

• **Angelacheva, A.** (2017). Research on the cognitive performances of students in teaching “Man and nature” 5<sup>th</sup> grade (module Chemistry) – part I. *Scientific Researches of the Union of Scientists - Plovdiv, Series C, Technique and technology*, vol. XV, Plovdiv, 170-175, ISSN 1311-9419.

The three articles are functionally related and represent a theoretical and applied study of student achievement in the Man and Nature module of Chemistry 5<sup>th</sup> and 6<sup>th</sup> grade.

– In accordance with the requirements of the theory and methodology for the composition of tests, didactic tests have been developed to measure the achievement of students in mastering the curriculum content of substances and their properties, 5<sup>th</sup> and 6<sup>th</sup> grade.

– The tests were analyzed in two aspects – by expert evaluation and after testing in a representative sample of students and subsequent statistical processing of the empirical data. The results show that the qualities of the tests correspond to the rules and norms presented in the specialized literature for composing criterion-referenced tests.

– The identified cognitive learning outcomes are compared with those set out in the Curriculum for 5<sup>th</sup> and 6<sup>th</sup> grade expected results and conclusions are formulated.

[publication № 19]

• **Angelacheva, A.** (2017). Invariant of educational technology for study of oxidation-reduction processes (in the 10<sup>th</sup> grade). *Journal of International Scientific Publications: Educational Alternatives*, vol. 15, 279-290, ISSN

---

1313-2571, Abstracting/Indexing: Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

Educational technology is an important component of the learning process, along with objectives, learning content and monitoring of learning outcomes.

– The performed attribute analysis of the main concepts included in the educational content of redox processes, as well as the identified main content issues are the basis for a reasoned choice of educational technology components.

– The theoretically grounded didactic components are presented in two relatively independent but interrelated blocks – a block reflecting the organization of the learning activity and a block for the control and evaluation of the learning activity.

– The invariance of the created technology is determined by the relative constancy of the didactic components in the model – a problem-research approach, realized with the help of learning chemistry experiments and learning chemistry tasks, presented in the form of working cards and different ways (techniques) of working with text and solved in the conditions of group organized learning activity. The dynamic alternation of the constituent elements determines the variation of the technology.

– The appropriateness of the created educational technology has been proved through a pedagogical experiment.

[publication № 22]

• **Angelacheva, A.** (2015). Didactic test "I-B Group of the Periodic table" (10<sup>th</sup> grade). *Journal of International Scientific Publications: Educational Alternatives*, vol. 13, 596-606, ISSN 1314-7277, Abstracting/Indexing: Scientific Electronic Library eLIBRARY Russia, China National Knowledge Infrastructure (CNKI) Scholar, Polish Scholarly Bibliography.

The problem of objective diagnosis and measurement of the level of knowledge and skills of students is one of the main problems of educational practice.

– By analyzing the content of the I-B group, the basic chemical concepts in its study are brought out. Students' knowledge and skills are identified and can be monitored and assessed.

– The developed test problems cover essential points of the curriculum content for Group I-B of the periodic system. The tasks are arranged according to the predetermined levels of students' achievement and the criteria for their assessment.

– The qualities of the test items and of the test were examined after testing. The results of the students' achievement in learning the specific content are statistically processed and interpreted.

– The created didactic test can be used both to register students' achievements and to develop students' cognitive interest and logical thinking.

---

---

**The main scientific contributions in the publications submitted for the competition can be summarized as follows:**

**Contributions on the thematic area 1. Teaching chemistry experiment:**

♦ The long-term research of the participant in the competition in the thematic area is summarized in the monograph “Experiment and observation in chemistry education”.

♦ The more important essential characteristics of experiment and observation as basic methods of scientific and educational knowledge are revealed.

♦ A methodology for the application of the teaching chemistry experiment in the preparation of students – future chemistry teachers was created. The effectiveness of the constructed methodology in terms of the students’ cognitive performance with emphasis on their natural science literacy is proved through a pedagogical experiment.

♦ Chemistry teaching experiments have been selected and constructed to illustrate the causes of Earth’s increasing greenhouse effect and can be used to illustrate the chemistry teaching process in relation to enriching students’ environmental awareness.

♦ Teaching chemistry experiments are proposed to demonstrate the presence of harmful substances in cigarette smoke; experiments that illustrate the effects of cigarette smoke on living organisms.

♦ Laboratory exercises included in the laboratory practical “Analysis of soil samples” are developed to enrich the system of knowledge, skills and attitudes related to environmental protection in the profiled training in chemistry.

♦ Enriched in the literature are described variants of teaching experiments related to the demonstration of the properties of metals of groups IA and IIA of the periodic system.

♦ A model was created for conducting student exercises in the course “Methodology and Technique of Educational Chemical Experiment”.

♦ The place and role of the chemical experiment in the application of the problem-based approach in chemistry education related to the study of the theory of electrolytic dissociation is outlined.

♦ A textbook “Chemistry – Observations and Experiments” has been created to present the 16 topics developed in the non-metals curriculum. Special emphasis is placed on the possibilities of the learning experiment and the learning tasks for the formation and development of social and civic competences in students.

♦ A textbook “Methodology and Technique of Educational Chemical Experiment” in 2 parts (the first part is independent and the second – with the first author) is developed in accordance with the curriculum of the same-named discipline of the training of students – future chemistry teachers. The guide can also be used by chemistry teachers in the experimental study of substances and chemical processes.

---

---

**Contributions on the thematic area 2. Environmental education in secondary school chemistry education:**

♦ On the basis of a defended dissertation for the award of the PhD degree the book “Contemporary aspects of environmental education in chemistry education in secondary school” was created.

♦ A didactic model for the implementation of environmental education in the process of chemistry education is developed.

♦ The content and interrelationships of concepts related to environmental education are defined. A definition of environmental education is provided.

♦ The objectives of chemistry education are updated in terms of environmental knowledge and skills and students’ values towards the environment.

♦ The possibilities of the main components of the chemistry curriculum (facts, concepts, laws, laws and theories) for the implementation of environmental education are outlined.

♦ Correlations between environmental knowledge and students’ value orientations towards the environment were investigated.

♦ Criteria for selection and composition of chemistry teaching tasks with ecological orientation are derived.

♦ Different organizational forms (lessons, seminars for new knowledge and for summarizing knowledge, role-plays) on ecological topics are developed.

♦ Didactic tests for the diagnosis of the ecological culture of students in general and specialized chemistry education are constructed.

♦ A version of educational technology for the implementation of environmental education in the process of chemistry education is created.

♦ A diagnostic study of the productivity of students’ acquisition of concepts related to the knowledge of the substance water in 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> grade.

♦ A rich didactic material (lessons, chemical experiments, learning tasks, etc.) has been created that can be used in chemistry education to enhance students’ environmental education.

**Contributions on the thematic area 3. Organization and control of the chemistry teaching process:**

♦ The research of the participant in the competition on the problem of effective organization of the chemistry teaching process is reflected in the monograph “Organizational forms of chemistry teaching”, which is not presented as a habilitation thesis.

♦ The structure and stages of different types of chemistry lessons, some classroom-non-classroom and extracurricular forms of organization of chemistry education are outlined.

♦ Models for developing a chemistry lesson plan and outline, for conducting an observation, and for analyzing a chemistry lesson are proposed.

- ◆ Methodological developments of different types of chemistry lessons have been created, which can be used directly in pedagogical practice.

- ◆ Educational technology for studying redox processes in general and specialized chemistry education is developed.

- ◆ Didactic tests were constructed to ascertain the students' learning of chemistry. The qualities of the test problems and of the tests in general have been demonstrated by a priori and by a posteriori analysis.

Complied by:

Chief Assistant Antoaneta Angelacheva, PhD