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DOI: <https://doi.org/10.24195/2414-4665-2018-4-8>**Olena Anichkina,***PhD (Candidate of Pedagogical Sciences),
senior lecturer, Department of Chemistry,***Olha Avdieieva,***post-graduate student, Department of Pedagogy,***Olena Yevdochenko,***teaching assistant, Department of Chemistry,
Zhytomyr Ivan Franko State University,
42, Berdychivska Str., Zhytomyr, Ukraine*

FUTURE CHEMISTS' EXPERIMENTAL COMPETENCE FORMATION

*The article deals with the issue of Chemistry students' experimental competence formation in professional training at higher educational institutions. In the empirical study, the levels of the experimental competence of future chemists (low, medium, sufficient, high) on the basis of selected components (motivational, cognitive, operational, activity) in accordance with selected criteria and corresponding indicators were determined. According to the initial assessment of the respondents' competence it has been found that most of them have an average level of its maturity. In order to improve it, there has been conducted an experiment, which involved introducing the following stages of future chemists' experimental competence formation in the process of training: focus on mastering the experimental competence; acquisition of theoretical chemical knowledge; mastering practical skills; gaining professional experience of the experimental competence application. The effectiveness of forming the experimental competence of future chemists according to the identified components has been proved by statistically significant positive changes. The reliability of the obtained results has been proved by means of Student's *t*-test.*

Keywords: *experimental competence, components, maturity levels, criteria, indicators, professional training of chemists, chemical experiment.*

Introduction

The training of Chemistry students at higher educational institutions requires adapting them to diverse, dynamic and varied work conditions. Students majoring in the 102 specialty "Chemistry" will be qualified as chemists and may be hired in accordance with the National Qualifications Framework for Chemical Production, chemical research institutes, laboratories of various food, cosmetics, pharmaceutical and other sectors of the national economy. Such a wide field of future work requires young specialists to have sufficiently flexible knowledge and skills, the formation of motivation for life-long learning, the existence of a stable interest in improving and optimizing work conditions. That is, a future chemist should be ready to perform professional duties in variable, non-standard, diverse conditions. A competence-based approach can be used as an instrument of such a training. After all, competence is interpreted in information sources as the ability to act under conditions of uncertainty (Lebedev, 2004); sufficient level of professional knowledge and skills of a specialist (Pometun, 2005) and his or her willingness to make optimal decisions on their basis (Shaposhnikov, 2006); a system of interrelated spheres of activity: motivational theoretical, practical-applied and research-reflexive (Rudenko, 1999).

The review of curricula of the "Chemistry" specialty regarding the list of competencies and programmed learning outcomes suggests that the training of a competitive specialist requires not only the accumulation of a signifi-

cant system of knowledge and skills but also the formation of the initial practical experience of their application, the desire to achieve optimal results, the formation of beliefs in the necessity and significance of the profession of chemist for a particular person, enterprise and state, the need to succeed in the chosen specialty.

The modernization of teaching Chemistry at secondary schools, which has been taking place in an intensive way throughout recent 10 years and greatly changed the system of education in Ukraine, has led to the transition from knowledge-based teaching to the competence-based one. Instead, the system of obtaining an academic degree in Chemistry is methodically stable enough due to the experience gained by institutions of higher education, the proven effectiveness of the methods and means of teaching, lack of teaching materials to teach specific disciplines in higher education and personal experience as well as professional qualifications of teachers in classical institutions of higher education.

Significant changes in the teaching of Chemistry at school have led to a transformation of qualitative characteristics of university entrants' proficiency, and, accordingly, first-year university students. The quality of training Chemistry students, the formation of their professional, and in particular, experimental competence depends on the relationship of teaching systems at schools and universities, the creation of a single trajectory of chemical education.

Thus, achieving success in the training of chemists requires addressing the contradictions: between the current level of the chemical science development and the willingness of young professionals to work in this area; between the significance of the experiment in chemists' work and its use as a method of training at school and university.

In modern psychological, pedagogical and scientific literature, the classification of methods of cognition is suggested (Hesse-Biber, 2015; Walliman, 2011) and a role of an experiment in a pedagogical study is defined (Horakova, Houska, 2014). The conducted scientific studies review has made it possible to note the absence of systematic, complex studies of the "chemists' experimental competence" concept, its main components, as well as methodology for the formation of the experimental competence of Chemistry students.

Aim and Tasks

The paper aims to provide theoretical substantiation and experimental verification of the effectiveness of future chemists' experimental competence formation according to the determined components in the process of professional training.

The following tasks are set:

1. To characterize the role of the experimental competence in the training of chemists, to determine its content; to identify basic knowledge, skills, motives necessary for future chemists for mastering the chemical experiment.
2. To define components, criteria, indicators and levels of the future chemists' experimental competence maturity in the context of their professional training.
3. To check the effectiveness of future chemists' experimental competence formation in the process of training according to the identified components and the reliability of research outcomes using Student's t-test.

Research Methods

The experiment involved 104 Chemistry students, as well as 7 university teachers. The experiment was conducted at Zhytomyr Ivan Franko State University.

The respondents were divided into control and experimental groups. Their homogeneity was checked with the help of Student's t-test. The first group consisted of 51 people, and the second one involved 53 respondents. The comparison of the critical value of Student's t-test (1.984) at the significance level of 0.05 with measured components (motivation – 1.861, cognitive – 1.468, operational – 0.820, activity – 1.726) has shown that the differences between the groups are random, since no value exceeded the critical one, and we can choose the first group as a control, and the second one – as experimental.

The maturity of the respondents' experimental competence was assessed with the help of Success Motivation Scale by T. Ehlers, Work Motivation Scale by K. Zamfir in the modification of A. Rean (Nemov, 2001). The respondents' knowledge was evaluated by means of testing tasks providing four variants of answers; the maturity of basic experimental skills was assessed by means of obser-

vation, and the desire to achieve success in the profession – with the help of expert evaluation of projects. All the tasks used had four levels of difficulty. The use of mathematical statistics enabled us to determine the reliability of the experimental results obtained.

In accordance with the objectives of the study, the levels of the maturity of future chemists' experimental competence as well as the corresponding scales were distinguished. We used a four-level scale of future chemists' experimental competence maturity including low, medium, sufficient and high levels.

Theoretical Study Results

Within the framework of the conducted research the following interpretation of competence concept was used: it is a person's ability for conscious, rational activity in changing conditions, effective addressing of life challenges.

Competency is a normative, ideal goal of an educational process that simulates the quality of a graduate, and competence is a result, level of manifestation (maturity). The notion of competency is related to the content of work, and competence is related to a person, the ability to act effectively in standard and non-standard situations (Skarbich, 2011).

Among the competences that a chemist should possess, they distinguish special (professional, major) competencies, the formation of which is the basis of future work. A competitive specialist in the field of chemistry possesses a system of mature competencies, which makes him or her competitive and the labor market and provides opportunities for further professional growth.

Professional competence in the literature is considered to be the possession of knowledge, skills, and norms necessary for the performance of professional duties, psychological qualities and real work in accordance with standards and norms (Zhebrovskiy, 2000). It is expressed in professional knowledge, the feature of which is the complexity and inspiration (Volkova, 2002).

We share the idea that professional competence is a complex integral intellectual, professional and personal phenomenon, which is formed in professional training and is manifested, developed and improved in the process of work, and the effectiveness of its use depends significantly on the types of theoretical, practical and psychological readiness for it, personal, professional and individual qualities, perception of goals, values, content and features of this activity (Voloshina, 2001).

We consider professional competence of a chemist as an integrated set of knowledge, skills, motives and ways to perform duties, as well as psychological qualities necessary for their successful implementation. A student acquires professional competence as a result of studying at a higher educational institution, and its maturity serves as a qualitative characteristic of mastering a profession, which arises only on the basis of awareness of the aspiration of an individual to the chosen kind of work.

Experimental competence is a holistic, systematic phenomenon consisting of a set of relevant mental and

practical abilities, skills, cognitive and social motives, as well as methodological knowledge, is a product of persistent, purposeful educational and cognitive activities (Halatiuk, 2010).

Regarding the concept of professional competence in terms of an experiment we consider the experimental competence as a leading result of the training of a future chemist at a higher educational institution. We interpret it as a conscious ability to select, plan, organize, implement in practice and analyze the results of a chemical experiment to solve practical tasks at work.

Given the experience of previous studies dealing with chemical experiments skills that form the basis of the experimental competence, we distinguish the following knowledge, skills and motivation necessary for performing professional duties:

- understanding the role and significance of the chemical experiment in work;
- conscious formation of skills and active use of a chemical experiment in practice;
- knowledge of theoretical foundations of chemistry that explain chemical reactions and properties of chemicals;
- knowledge and skills of basic operations of a chemical experiment;
- rational use of chemical equipment, reagents to achieve the purpose of an experiment;
- the ability to use a chemical experiment as a specific way of performing professional duties;
- acquisition of initial professional experience of using experimental methods of cognizing chemical processes and phenomena.

We distinguish the following components of future chemists' experimental competence: motivational, cognitive, instrumental, activity.

A conscious desire to master the chemical experimental skills as a leading method of chemist's work, understanding its significance for the profession, the desire to apply it in educational activities and further work make the motivational component of the future chemist's experimental competence. The criterion characterizing this component is the awareness of internal needs, aspirations, interests and goals of mastering the experimental competence.

The indicators of this criterion are as follows: stable interest in mastering the experimental method of chemical science cognition; understanding the leading role of a chemical experiment in the work of a chemist; intensification of the need to use a chemical experiment in practice; understanding the purpose of mastering the experimental competence.

The system of conscious profound theoretical knowledge of future chemists necessary for the formation and continuous improvement of the experimental competence makes a cognitive component. It is characterized by the following criterion – cognitive activity regarding continuous enrichment of the system of theoretical

knowledge in order to improve the level of the experimental competence.

Indicators of this criterion are as follows: maturity of chemical knowledge necessary to explain the mechanism of chemical processes and the properties of chemicals; experimental knowledge and skills necessary for successful selection, planning and organization of an experiment and interpretation of the results obtained; cognitive activity aimed at constant updating of the acquired knowledge, skills and their creative use.

The instrumental component determines the maturity of practical skills of future chemists necessary for the performance of experimental activities.

Indicators of the criterion are as follows: basic skills of conducting a chemical experiment; profound skills in dealing with chemical reagents, devices necessary for experimental activities.

The activity component provides effective experimental training and the maturity of the experimental competence at a proper level. Its criterion is active qualities of future chemists in the process of achieving professional goals.

The following indicators have been distinguished: integrated skills of selection, planning, organization, implementation, interpretation of the results of a chemical experiment to solve professional tasks; experimental skills of performing practical tasks; initial professional experience gained in the learning process.

Empirical Study Results

The results of the initial assessment have made it possible to find that, on average, 33.65% of the respondents have a low level of the experimental competence, most of them (40.38%) have an average level, 19.23% have a sufficient level, and only 6.73% have a high level of the experimental competence maturity.

The formative stage of the pedagogical experiment involved verifying the effectiveness of the formation of the distinguished components of the experimental competence in the process of training.

The formation of future chemists' experimental competence in the control group was carried out in a traditional way: using typical theoretical and practical tasks, experimental work in small groups, formation of average knowledge, skills and abilities, traditional self-study methods, using printed literary sources in the process of training.

In experimental groups, the formation of the experimental competence was carried out in stages, according to the theory of mental actions staged formation, distinguished components and principles of science, continuity, practical orientation, creativity, cooperation, variability, individualization, and efficiency. The following methods of implementation were chosen: a chemical experiment, observation, testing, project activity; means – chemical reagents, equipment necessary for conducting all kinds of a chemical experiment; pedagogical technologies of individualized training and staged formation of experimental skills; forms – lectures, laboratory classes, control papers,

individual work, self-study activities, project activity (Fig. 1).

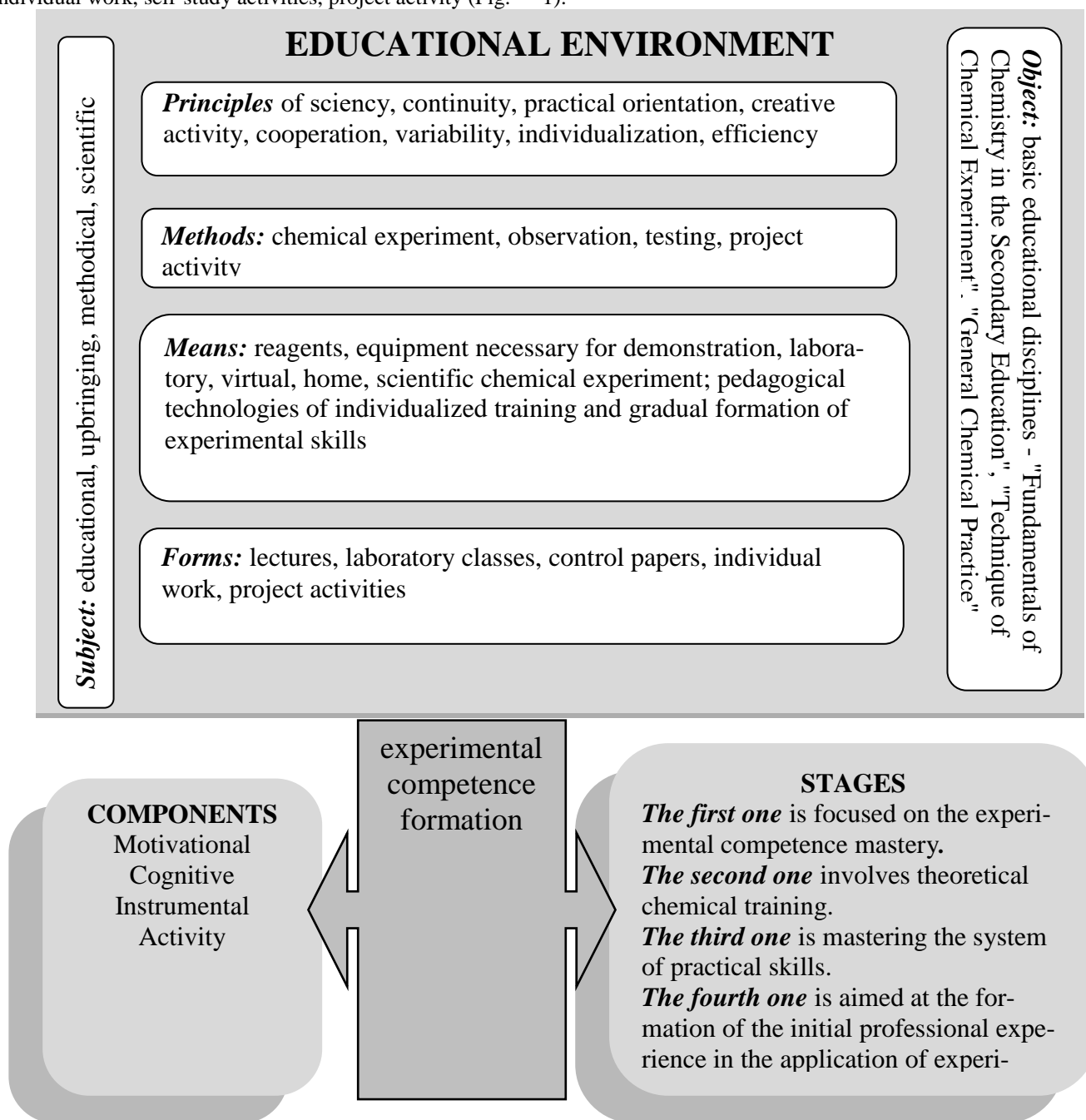


Fig. 1. Chemistry Students' Experimental Competence Formation according to Distinguished Components

Thus, the first stage (focus on the experimental competence improvement) was aimed at making teachers understand the significance of the experiment in chemical science and the profession of a chemist, interest in conducting chemical experiments. At this stage, during lectures and laboratory classes chemical experiments were demonstrated with active involvement of students.

The second stage (theoretical chemical training) involved the development, systematization and improvement of the chemical and experimental knowledge necessary to

explain properties of chemical substances and chemical processes, the formation of skills of choosing, planning and interpretation of the results of a chemical experiment by means of learning a specific generalizing discipline "Fundamentals of Chemistry in Secondary Education".

The third stage (mastering the system of practical skills) aimed to form individual experimental skills of future chemists to carry out a laboratory experiment, implement its basic operations in practice, gain the ability to construct experimental installations for addressing educational issues. This

stage was implemented during lessons on the discipline “Chemical Experiment Technique”, through the introduction of individualized workshops.

The purpose of implementing the fourth stage (the formation of initial professional experience in the experimental competence application) was the formation of integrated knowledge and skills necessary for a future chemist. This stage was based on chemical practice by involving students in the project activity, which ensures the systematization of the existing knowledge, skills and abilities, the motivation to achieve success in experimental activities, the formation of individual primary

practical experience in using a chemical experiment to solve complex tasks at work.

The verification of future chemists’ experimental competence formation was carried out using tests (to assess the level of knowledge), questionnaires (to evaluate the level of motivation), expert evaluations (to assess the level of skills), practical (professionally oriented) tasks and projects (to examine the maturity of the experimental competence components).

At the beginning of the formative stage of the pedagogical experiment, initial levels of future chemists’ experimental competence maturity were determined (Table 1).

Table 1.

Maturity Levels of the Respondents’ Experimental Competence at the Beginning of the Experiment

Level	Low				Average				Sufficient				High			
	CG, n=51		EG, n=53		CG, n=51		EG, n=53		CG, n=51		EG, n=53		CG, n=51		EG, n=53	
Group	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Component																
Motivational	19	37.25	11	20.75	25	49.03	29	54.72	5	9.80	10	18.87	2	3.92	3	5.66
Cognitive	13	25.49	5	9.44	23	45.10	18	33.96	10	19.61	22	41.51	5	9.80	8	15.09
Operational	20	39.22	19	35.85	21	41.18	20	37.73	6	11.76	7	13.21	4	7.84	7	13.21
Activity	25	49.03	15	28.30	18	35.29	29	54.72	4	7.84	5	9.43	4	7.84	4	7.55
Mean value		37.75		23.58		42.65		45.28		12.25		20.75		7.35		10.38

At the same time, mean values of the experimental competence maturity of each of the studied groups were calculated. The obtained results make it possible to state that the vast majority of future chemists of the control (42.65%) and experimental (45.28%) groups have an average level of the experimental competence maturity; low – 37.75% (CG) and 23.58% (EG); sufficient –

12.25% (CG) and 20.75% (EG); and only 7.35% (CG) and 10.38% (EG) have the high level.

After implementing the experimental study, the reassessment of the maturity levels of future chemists’ experimental competence was also carried out and the following results were obtained (Table 2).

Table 2.

Levels of Future Chemists Experimental Competence Maturity at the end of the Experiment

Level	Low				Average				Sufficient				High			
	CG, n=51		EG, n=53		CG, n=51		EG, n=53		CG, n=51		EG, n=53		CG, n=51		EG, n=53	
Group	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Component																
Motivational	13	25.47	5	9.43	22	43.14	18	33.97	11	21.57	22	41.51	5	9.82	8	15.09
Cognitive	6	11.76	4	7.55	16	31.37	10	18.87	16	31.37	12	22.64	13	25.50	27	50.94
Operational	13	25.49	3	5.66	19	37.25	21	39.62	10	19.61	10	18.87	9	17.65	19	35.85
Activity	17	33.33	3	5.66	24	47.06	19	35.85	4	7.84	17	32.07	6	11.77	14	26.42
Mean value		24.02		7.08		39.71		32.08		20.10		28.77		16.18		32.08

The analysis of the formative experiment results has shown positive dynamics of future chemists’ experimental competence development according to the levels. Thus, the number of the respondents with a high level of the experimental competence reached 16.18% (CG) and 32.08% (EG), a sufficient level – 20.10% (CG) and 28.77% (EG), an average level – 39.71% (CG) and 32.08% (EG), and a low level – 24.02% (CG) and 7.08% (EG).

For checking the statistical significance of differences in the results obtained, sampled mean values, sampled dispersions were calculated.

Having compared the obtained values according to Student’s t-test by the components (motivational – 2.972, cognitive – 2.133, operational – 2.783, activity – 4.465) with its critical value (1.984) at the significance level = 0.05, we can conclude that in the process of the experimental competence formation the described heterogeneity of the groups increased and exceeded the critical value.

That is, the differences between the results of the groups are not random, which indicates the effectiveness of the introduced professional training.

Discussion

The scientific and technological development of science in general and chemistry in particular, the widespread use of modern technology for research in the field of chemistry, a significant increase in the role of chemistry in addressing basic challenges of the society requires a modern chemist to possess high-level basic methods of performing professional duties. Such abilities are acquired at a higher education institution and require students to master the experimental method of cognizing chemical substances and phenomena, the formation of skills and abilities to choose, organize, plan, prepare, perform and interpret the results of a chemical experiment, that is, the formation of chemist's experimental competence.

The issues of the experimental competence formation were considered in the works of Ukrainian and foreign scientists A. Hrabovyi (2012), O. Hulai (2016), I. Nikolaieva (2018), F. Karsli, F. Yaman, A. Ayas (2010), Y. Tolsdorf, S. Markic (2017), and others. Its formation in pharmacists, builders, teachers of chemistry has been studied in details. It should be noted that the results obtained are consistent and do not contradict the conclusions of scientists and indicate the need to study the formation of the experimental competence in future chemists because it is especially significant for the chemical profession.

The generalization of the obtained results makes it possible to conclude about great possibilities of future chemists' experimental competence formation in the process of professional training and the effectiveness of its formation according to the determined components, since the majority (60.85%) of the respondents in our study have reached a sufficient and high levels of its maturity.

REFERENCES

1. Volkova, N.P. (2002). *Pedahohika: posibnyk dlia studentiv vyshchyykh navchalnykh zakladiv [Pedagogy: textbook for university students]*. Kyiv: Vydavnychiy tsentr «Akademiiia» [in Ukrainian].
2. Voloshina, M.S. (2001). *Professionalnaia inkulturatsiia v obrazovanii: teoriia i praktika: Monografiia [Professional inculturation in education: theory and practice: monograph]*. Novokuznetsk: IPK [in Russian].
3. Halatiuk, M.Iu. (2010). Formuvannia eksperymentalnoi komponenty u konteksti rozvytku navchalno-piznavalnoi kompetentnosti starshoklasnykiv [Formation of experimental competence in the context of senior school students; cognitive competence development]. *Zbirnyk naukovykh prats Kamianets-Podilskoho natsionalnoho universytetu imeni Ivana Ohiiienka – Collection of scientific works of Kamianets-Podilskyyi National University named after Ivan Ogiienko*, 16, 143-145. Kamianets-Podilskyyi: Kamianets-Podilskyyi natsionalnyi universytet imeni Ivana Ohiiienka [in Ukrainian].
4. Hrabovyi, A. K. (2012). *Teoretyko-metodychni zasady navchalnoho khimichnoho eksperymentu v zahal-*

Conclusions

1. Scientific sources review has made it possible to conclude that the formation of the experimental competence of a specialist in the chemical field is one of the main tasks of higher educational institutions, since it forms the basis for further work. After all, for chemistry, an experiment acts as a means of its creation (cognition), and a means of transferring chemical knowledge to the next generation (teaching).

2. As a result of the conducted research there have been identified the components (motivational, cognitive, instrumental, activity), corresponding criteria, indicators and levels (high, sufficient, average, low) of the maturity of future chemists' experimental competence in the process of training.

3. The effectiveness of future chemists' experimental competence formation according to the determined components proves the results of the formative stage of the pedagogical experiment. On average, the number of the respondents with a high level of experimental competence increased by 8.83% (CG) and 21.7% (EG), a sufficient level – by 7.85% (CG) and 8.02% (EG), respectively. At the same time, the number of the students whose experimental competence remained at the average level decreased by 2.94% (CG) and 13.2% (EG), and at a low level – by 13.73% (CG) and 16.5% (EG), respectively.

The reliability of the research outcomes has been proved by means of the Student's t-test for independent samples.

In our further research, we are going to examine pedagogical foundations of using individualized training in the workshops of the main educational chemical disciplines, didactic capabilities of projects use at all stages of the university training.

noosvitnikh navchalnykh zakladakh: monografiia [Theoretical and methodical foundations of educational chemical experiment at secondary schools: monograph]. Cherkasy: ChNU imeni Bohdana Khmelnytskoho [in Ukrainian].

5. Hulai, O. I. (2016). *Teoretyko-metodychni osnovy profesiinoy pidhotovky maibutnykh fakhivtsiv budivelnoho profilu v umovakh nepererвної osvity [Theoretical and methodical bases of building students' professional training in terms of continuous education]*. *Extended abstract of candidate's thesis*. Vinnytsia: Vinnytskyi derzh. ped. un-t im. M. Kotsiubynskoho [in Ukrainian].

6. Lebedev, O.E. (2004). *Kompetentnostnyi podkhod v obrazovanii [Competence-based approach in education]*. *Shkolnye tekhnologii – School technologies*, 5, 3-12 [in Russian].

7. Nemov, R.S. (2001). *Psikhologiya: Ucheb. dlia stud. vyssh. ped. ucheb. zavedenii: v 3 kn. [Psychology: textbook for university students]*. 4th ed. Moscow: VLADOS [in Russian].

8. Nikolaieva, I.M. (2018). *Eksperymentalna perevirka efektyvnosti metodychnoi systemy formuvannia*

kompetentnosti v khimii maibutnix bakalvariv tekhnologii medychnoi diahnostryky ta likuvannia u vyshchykh medychnykh navchalnykh zakladakh Ukrainy [Experimental verification of the effectiveness of the methodical system of chemical competence of future specialists in medical diagnostics and curing at higher medical educational institutions of Ukraine]. *Science Rise: Pedagogical Education*, 3 (28), 38-40. doi: 10.15587/2519-4984.2018.127406 [in Ukrainian].

9. Pometun, O.I. (2005). Formuvannia hromadianskoi kompetentnosti: pohliad z pozytsii suchasnoi pedahohichnoi nauky [Forming civil competence: view from the standpoint of modern pedagogy]. *Visnyk proqram shkilnykh obminiv – Bulletin of school exchange programs*, 23, 18-20 [in Ukrainian].

10. Zhebrovskiy, B.M. (2000). *Profesiina etyka vchytelia: chas i vymohy [Professional ethics of a teacher]*. Kyiv: Irpin [in Ukrainian].

11. Rudenko, T. B. (1999). Formirovanie didaktiko-metodicheskoi kompetentnosti budushchego uchitelia nachalnykh klassov v sovremennykh usloviakh [Formation of didactic and methodical competence of a future primary school teacher in modern conditions]. *Candidate's thesis*. Volgograd [in Russian].

12. Skarbich, S.N. (2011). *Formirovanie issledovatel'skikh kompetentsii uchashchikhsia v protsesse obuchenii resheniiu planimetriceskikh zadach [Formation of research competence of students in the process of teaching them to do planimetric sums]*. Moscow: FLINTA [in Russian].

ЛІТЕРАТУРА

1. Волкова Н.П. Педагогіка: посібник для студентів вищих навчальних закладів / Н. П. Волкова. – К. : Видавничий центр «Академія», 2002. – 576 с.

2. Волошина М.С. Професійна інкультурація в освіті: теорія і практика: Монографія / М. С. Волошина. – Новокузнецк : ИПК, 2001. – 114 с.

3. Галатюк М.Ю. Формування експериментальної компоненти у контексті розвитку навчально-пізнавальної компетентності старшокласників / М. Ю. Галатюк // Збірник наукових праць Кам'янець-Подільського національного університету імені Івана Огієнка. Серія педагогічна. Вип. 16 : Формування професійних компетентностей майбутніх учителів фізико-технологічного профілю в умовах євроінтеграції. – Кам'янець-Подільський : Кам'янець-Подільський національний університет імені Івана Огієнка, 2010. – С. 143-145.

4. Грабовий А. К. Теоретико-методичні засади навчального хімічного експерименту в загальноосвітніх навчальних закладах : [монографія] / А. К. Грабовий. – Черкаси : ЧНУ імені Богдана Хмельницького, 2012. – 376 с.

5. Гулай, О. І. Теоретико-методичні основи професійної підготовки майбутніх фахівців будівельного профілю в умовах неперервної освіти : автореферат. д-ра пед. наук, спец.: 13.00.04 - теорія і методика професійної

13. Shaposhnikov, K. V. (2006). Kontekstnyi podkhod v protsesse formirovaniia professionalnoi kompetentnosti budushchikh lingvistov-perevodchikov [Context approach in the process of future philologists-translators' professional competence formation]. *Extended abstract of candidate's thesis*. Ioshkar-Ola [in Russian].

14. Fethiye, Karşlı, Fatma, Yaman, Alipaşa, Ayas. (2010). Prospective chemistry teachers' competency of evaluation of chemical experiments in terms of science process skills. *Procedia - Social and Behavioral Sciences*, 2, 778-781. doi: org/10.1016/j.sbspro.2010.03.101.

15. Hesse-Biber, S. (2015). The problems and prospects in the teaching of mixed methods research. *International Journal of Social Research Methodology*, 5, 463-477. doi: 10.1080/13645579.2015.1062622

16. Horakova, T., Houska, M. (2014). On Improving the Experiment Methodology in Pedagogical Research. *International Education Studies*, 9, 84-98. doi: 10.5539/ies.v7n9p84.

17. Walliman, N. (2011). *Research methods the basics*. London-New York: Routledge, Taylor & Francis Group.

18. Yannik, Tolsdorf, Silvija, Markic. (2017). Exploring Chemistry Student Teachers' Diagnostic Competence - A Qualitative Cross-Level Study. *Education Sciences – Open Access Journal*, 86. doi:10.3390/educsci7040086.

освіти / О. І. Гулай. – Вінниця : Вінницький держ. пед. ун-т ім. М. Коцюбинського, 2016. – 40 с.

6. Лебедев О.Е. Компетентностный подход в образовании / О.Е. Лебедев / Школьные технологии. – 2004. – № 5. – С. 3-12.

7. Немов Р.С. Психология: Учеб. для студ. высш. пед. учеб. заведений: в 3 кн. / Р.С. Немов. – 4-е изд. – М.: ВЛАДОС, 2001. – Кн. 3: Психодиагностика. Введение в научное психологическое исследование с элементами математической статистики. – 640 с.

8. Ніколаєва І.М. Експериментальна перевірка ефективності методичної системи формування компетентності в хімії майбутніх бакалаврів технології медичної діагностики та лікування у вищих медичних навчальних закладах України / І.М. Ніколаєва // *Science Rise: Pedagogical Education*. 2018. № 3 (28). С. 38-40. doi: 10.15587/2519-4984.2018.127406

9. Пометун О.І. Формування громадянської компетентності: погляд з позиції сучасної педагогічної науки / О.І. Пометун // *Вісник програм шкільних обмінів*. – 2005. – № 23. – С. 18-20.

10. Професійна етика вчителя: час і вимоги / за ред. Б.М. Жебровського, Л.М. Ващенко. – К. : Ірпінь, 2000. – 257 с.

11. Руденко Т. Б. Формирование дидактико-методической компетентности будущего учителя

начальных классов в современных условиях: дис. канд. пед. наук. 13.00.04 / Т. Б. Руденко. – Волгоград, 1999. – 181 с.

12. Скарбич С.Н. Формирование исследовательских компетенций учащихся в процессе обучения решению планиметрических задач: [учеб. пособие] / С.Н. Скарбич – М. : ФЛИНТА, 2011. – 194 с.

13. Шапошников К. В. Контекстный подход в процессе формирования профессиональной компетентности будущих лингвистов-переводчиков : автореф. дис. на соискание научн. степени канд. пед. наук : спец. 13.00.08 «Теория и методика профессионального образования» / К. В. Шапошников. – Йошкар-Ола, 2006. – 26 с.

14. Fethiye Karşlı, Fatma Yaman, Alipaşa Ayas. Prospective chemistry teachers' competency of evaluation of chemical experiments in terms of science process skills / Karşlı Fethiye, Yaman Fatma, Ayas Alipaşa // Procedia - Social and Behavioral Sciences. – 2010. – Vol. 2. – Issue 2. – P. 778-781. doi: org/10.1016/j.sbspro.2010.03.101

15. Hesse-Biber S. The problems and prospects in the teaching of mixed methods research / S. Hesse-Biber // International Journal of Social Research Methodology. – 2015. – Vol. 18. – Issue 5. – P. 463–477. doi: 10.1080/13645579.2015.1062622

16. Horakova T., Houska M. On Improving the Experiment Methodology in Pedagogical Research / T. Horakova, M. Houska // International Education Studies. – 2014. – Vol. 7. – Issue 9. – P. 84–98. doi: 10.5539/ies.v7n9p84

17. Walliman N. Research methods the basics / N. Walliman. – London-New York: Routledge, Taylor & Francis Group, 2011. – 190 p.

18. Yannik Tolsdorf, Silvija Markic. Exploring Chemistry Student Teachers' Diagnostic Competence—A Qualitative Cross-Level Study / Tolsdorf Yannik, Markic Silvija // Education Sciences — Open Access Journal. 2017, Vol.7, Issue 86; doi:10.3390/educsci7040086

*Олена Анічкіна,
кандидат педагогічних наук, старший викладач кафедри хімії,
Ольга Авдєєва,
аспірант кафедри педагогіки,
Олена Євдоченко,
асистент кафедри хімії,
Житомирський державний університет імені Івана Франка,
вул. В. Бердичівська, 42, м. Житомир, 10008, Україна*

ФОРМУВАННЯ ЕКСПЕРИМЕНТАЛЬНОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ ХІМІКІВ У ПРОЦЕСІ ПРОФЕСІЙНОЇ ПІДГОТОВКИ

У статті теоретично доведено важливість і складність проблеми формування експериментальної компетентності майбутніх хіміків у процесі професійної підготовки в закладах вищої освіти. Здійснено аналіз різних наукових підходів, освітніх програм підготовки із метою встановлення значення експерименту в професійній підготовці хіміків. На основі синтезу існуючих трактувань сформульовано визначення поняття експериментальної компетентності майбутніх хіміків. Із огляду на визначну роль експерименту в професійній діяльності хіміка та проведений аналіз літературних джерел схарактеризовано систему знань, умінь, навичок і мотивів необхідних хімікам для виконання професійних обов'язків. У ході емпіричного дослідження було визначено рівні сформованості експериментальної компетентності майбутніх хіміків (низький, середній, достатній, високий) на основі виділених компонентів (мотиваційний, когнітивний, операційний, діяльнісний) у відповідності до обраних критеріїв і відповідних їм показників. Для проведення педагогічного експерименту з визначення ефективності формування експериментальної компетентності майбутніх хіміків було розроблено його теоретичні засади і програму. Констатувальний етап експерименту полягав у визначенні сформованості експериментальної компетентності в хіміків на завершальному етапі навчання. Його результати свідчать про досягнення більшістю випускників лише середнього рівня її сформованості. Формувальний етап експерименту відбувався за розробленими етапами формування експериментальної компетентності майбутніх хіміків у процесі професійної підготовки і включав: орієнтацію на оволодіння експериментальною компетентністю; набуття теоретичної хімічної підготовки; опанування системою практичних умінь; формування первинного професійного досвіду застосування експериментальної компетентності. Ефективність формування експериментальної компетентності майбутніх хіміків за визначеними компонентами доведена за статистично значущими позитивними змінами рівнів. Достовірність одержаних результатів дослідження доведена за допомогою параметричного критерію порівняння відмінностей середніх величин (t-критерію Стьюдента) для незалежних вибірок.

Ключові слова: експериментальна компетентність, компоненти, рівні сформованості, критерії, показники, професійна підготовка хіміків, хімічний експеримент.

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