

Teacher education: the key to quality education for future generations

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Abstract

Teacher education is an essential requirement for ensuring the quality and efficacy of education for the younger generation. Competent and well-prepared educators significantly impact the growth of their students' and pupils' competencies, expertise, and knowledge. Therefore, access to professional and pedagogical training that adequately equips educators to confront the complexities and demands of the contemporary educational landscape is critical. In this paper, we address the current issue of preparing teachers with professional qualifications in the science discipline of chemistry. Teacher education encompasses a wide range of requirements, such as professional development, the use of information technology, and pedagogical training. Understanding chemistry is essential for the further knowledge development of the young generation and for preparing them for future career opportunities. This paper highlights prospective measures and solutions that can help improve the current situation in the education sector. Together, we need to look for ways to increase the attractiveness of the profession of a chemistry-qualified teacher and thus promote the interest of future student-pre-service chemistry teachers in studying this science discipline.

Keywords: Teacher, Chemistry, Motivation, New trend, Education, Educational Environment

1 Introduction

The history of human activities shows the development of increasing demands on the teaching profession. Nowadays, education is coming to the forefront of society, which is supposed to form the personality of the pupil and student in the sense of his intellectual and moral improvement, to teach him to know himself and other people, to develop his independence, creativity, and critical thinking (Predanociová et al., 2016). Today, a teacher is not just a specialist who has mastered modern methods of education and upbringing and effectively

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uses technical means in the educational process but also continuously improves his professional competence (Mashrabjonovich, 2023).

Perignatova (2019) states that one of the primary factors influencing the choice of profession is the attractiveness of teaching. However, despite this importance and the growing interest in chemistry education, we face a shortage of teachers with professional qualifications in chemistry in schools.

The most important indicator of the teacher's professional competence is his readiness to use innovative forms and methods of teaching and the optimal use of modern multimedia technologies (Mashrabjonovich, 2023). As Enina (2023) states, the development of innovative forms and teaching methods is a prerequisite and a factor for the sustainable development of the educational sphere. The prerequisite for the success of graduates of teacher education programmes in solving problems in their everyday lives is the high quality of knowledge acquired during university education (Pramana et al., 2021).

A shortage of chemistry teachers can hurt the quality of teaching and student learning. Therefore, we must focus on this issue and find ways to resolve it. The characteristic feature of the teacher's professional activity is the adaptation of students to the educational environment, the demonstration of the characteristics of learning and self-education in the educational society and the realisation of the developmental function of learning in the school environment. The teacher's primary role is to actively organise activities to assign students effective ways of working with the knowledge that will enable them to navigate their learning environment and purposefully solve specific learning problems. It is vital to assess how the shortage of chemistry teachers affects our education system and identify areas where changes need to be made.

1.1 Chemistry and its Impact on the Education and Development of the Younger Generation

University education is the most important and best starting point for young people to acquire the knowledge necessary for their professional growth (Romanyshyn et al., 2019; Simonova et al., 2021). An essential prerequisite for each individual for his or her complete application in practice in the field of personal professional interest is completing a university education (Kopas-Vukasinovic, 2014). Chemistry is becoming an integral characteristic of the modern educational space.

Higher education's content, quality, and efficiency are influenced not only by the level of scientific and technical knowledge and dynamically developing production technologies, but above all by the requirements of social and production practice (Renz, Hilbig, 2020). In chemistry, we are at a time when its importance in everyday life and almost all fields (medicine, pharmacy, toxicology, environmental sciences, industry, and technology) is increasingly recognised. It is understandable that in such a changing environment, new

requirements for the content and forms of education are also being created (Kopas-Vukasinovic, 2014; Fischer et al., 2020; Enina, 2023).

The study programmes focused on Teaching Chemistry (combined) result from a long-term development process at universities in the Slovak Republic. Even at present, this process cannot be considered complete. The reasons for this are changing legal standards, new decrees, and regulations in the study programmes. They are aimed at technological and technical development and reactions to social changes, but especially the necessity to harmonise Slovak standards with European ones and their integration into the Slovak education system. Chemistry is one of the critical disciplines providing primary education in science and technology. The need to implement innovative forms and teaching methods in educational institutions' curricula stems from the fact that education that is not varied, motivating, and meaningful can become routine and hinder the training of highly qualified workers (Santos et al., 2020; Enina, 2023).

In this paper, we deal with the current issue of training teachers with professional qualifications in the natural science discipline of chemistry. Teacher education includes several components, such as professional development, the use of information technology, and pedagogical training. Understanding chemistry is essential for the continued knowledge development of the young generation and for preparing them for future career opportunities. This paper explores prospective measures and solutions that can help improve the current situation. It is our primary task to look for ways to increase the attractiveness of the profession of chemistry-qualified educators and to promote the interest of student-pre-service teachers in this science subject.

1.2 Education in the Study Programme Teaching Chemistry (combined)

The current situation of a shortage of teachers with professional qualifications in chemistry in primary schools is serious and deserves our attention. This problem does not concern only the subject of chemistry but most of the science disciplines. It is therefore important to assess how the shortage of science teachers affects our education system and the development of the young generation and identify areas where changes need to be made. We must focus on this issue and look for ways to resolve it.

Improving the quality and efficiency of higher education is now one of the priority tasks of our society. *Teaching and Educational Sciences* in the study programme *1.1.1 Teaching Chemistry Combined* has its social justification. Understanding chemistry is important for the further knowledge development of the young generation and for preparing them for future career opportunities. A shortage of chemistry teachers can harm the quality of teaching and learning for the younger generation.

Slovak universities such as Comenius University in Bratislava, Trnava University in Trnava, J. Selye University, Matej Bel University in Banská Bystrica, Catholic University in Ružomberok,

Pavol Jozef Šafárik University in Košice, and Constantine the Philosopher University in Nitra offer study programmes oriented towards the *Teaching of Chemistry in Combination*. Many of the universities offer a Bachelor's followed by a master's study programme. The primary task of the teacher-oriented study programmes is to ensure the quality preparation of pre-service teachers of science subjects for primary and secondary schools.

2 Constantine the Philosopher University in Nitra (Slovakia)

The Department of Chemistry of the Constantine the Philosopher University in Nitra offers its students, in addition to accredited Bc. and M.Sc. studies, rigorous proceedings and further education in extension studies. In chemistry, we are in a time when its importance in everyday life and other areas is increasingly recognised. Despite this importance and the growing interest in chemistry education, we face a significant shortage of chemistry-qualified teachers in primary and secondary schools.

Education at the Department of Chemistry of the Constantine Philosopher University in Nitra prepares pre-service teachers for bachelor studies in the following disciplines: General Chemistry, Chemical Calculations; Laboratory Technology, Fundamentals of Mathematics for Chemistry Teachers, Inorganic Chemistry; Laboratory Exercises in Inorganic Chemistry, Organic Chemistry 1, 2; Physical Chemistry 1, 2; Biochemistry 1, 2; Analytical Chemistry 1, 2; Laboratory Exercise in Organic Chemistry; Laboratory Exercise in Physical Chemistry, Laboratory Exercise in Biochemistry; Laboratory Exercise in Analytical Chemistry 1, 2; Didactics of Chemistry 1, 2; Theory of Chemical Bonding; Computer Modelling of Molecules; Instrumental Methods; Laboratory Exercises in Instrumental Methods; Technique and Didactics of School Experiments 1, 2; Selected Chapters in Organic Chemistry; Selected Chapters in Biochemistry.

The field of chemistry is implemented in most science disciplines in our universities and colleges. For this reason, many educators are also supplementing their education with another subject of interest: chemistry. Constantine the Philosopher University in Nitra also offers further education in extension studies (Act of the National Council of the Slovak Republic No. 138/2019 Coll.). To date, 28 graduates have completed their extension studies. Further education in the form of an extension 2-year study offers the following subjects for students: General Chemistry; Inorganic Chemistry, Chemical Calculations; Laboratory Exercise in Inorganic Chemistry, Organic Chemistry 1, 2; Laboratory Exercise in Organic Chemistry; Physical Chemistry; Biochemistry; Laboratory Exercise in Physical Chemistry, Laboratory Exercise in Biochemistry; Computer Modelling of Molecules; Processing of Experimental Data; Analytical Chemistry; Laboratory Exercise in Analytical Chemistry; Didactics of chemistry; Techniques and Didactics of School Experiments.

3 Methodology

Potential solutions and measures that could contribute to improving this situation led us to look for ways to find solutions. It is essential to look for ways to make the work of chemistry teachers more attractive and thus promote the interest of students current and pre-service teachers in the subject of chemistry in primary and secondary schools.

Participants

We focused on extension students who graduated from the Department of Chemistry at Constantine the Philosopher University in Nitra in 2010 - 2023. The sample consisted of 20 respondents. The respondents were practising teachers with several years of experience. We chose a survey method in the form of a questionnaire to find out the needs of practising teachers. Interviews with teachers took place before the survey and centred on the needs of students in various age groups and educational goals and objectives. The questionnaire items were designed to help gain an overview of the situation in specific schools while monitoring important information about the shortage of qualified chemistry educators.

Questionnaire

In terms of the questionnaire items prepared, the extension student respondents represented a group that provided relevant information to our survey results. The development of the questionnaire items was a key element. The focus of the questionnaire was the lack of teachers with professional qualifications in chemistry in primary and secondary schools and ways of addressing it. The questionnaire consisted of open and closed items. The logical structure of the questions for the questionnaire was arranged so that the questionnaire would be acceptable to the respondents and that we would obtain the most relevant data. The questionnaire consisted of a total of 15 items.

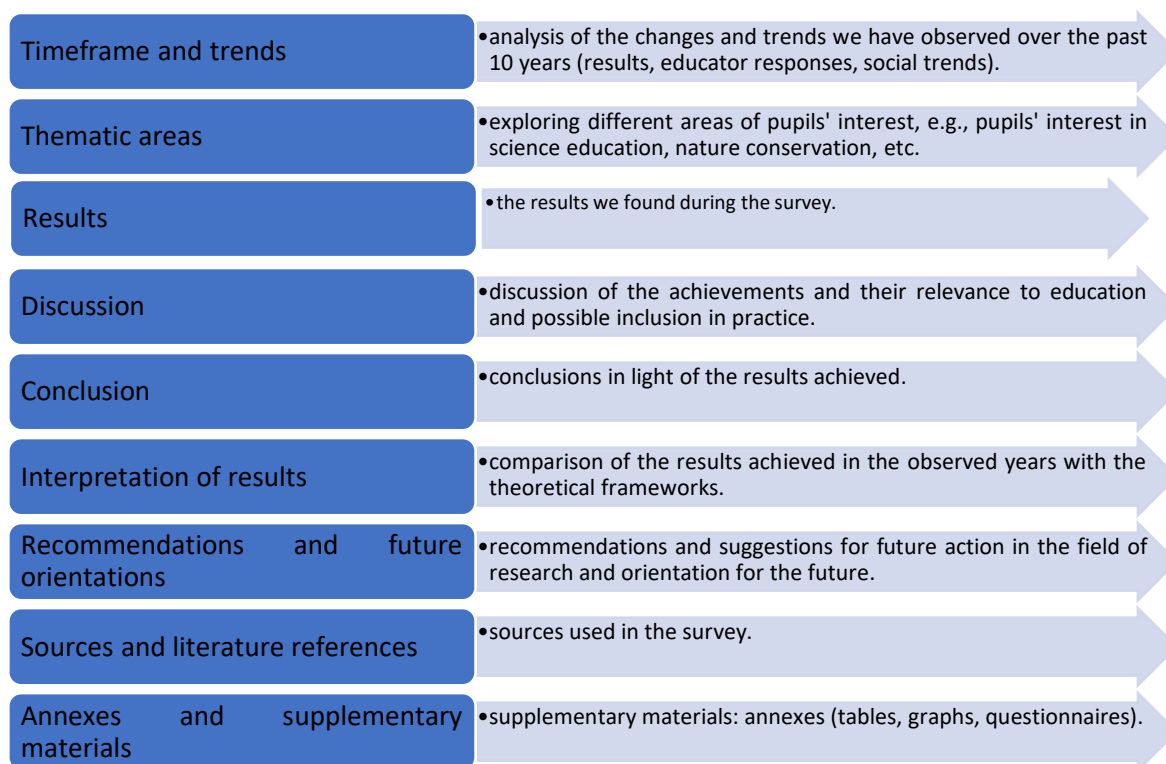
4 Results and Discussion

The survey aimed to find potential solutions and measures that could contribute to increasing the interest of students and practising teachers in chemistry. The actual aim was to improve the quality and efficiency of university education that considers the requirements of contemporary society, embedded in the social functions and fundamental objectives of the different types and levels of the education system. This intention also applies to chemistry, where an effort is made to emphasise the educational and upbringing functions systematically and purposefully within the educational process.

Extension studies in chemistry provide future graduates with new knowledge and practical skills, with an emphasis on laboratory work in the chemical disciplines. The professional competence of future chemistry teachers is a crucial goal. Increasing them will enable them to direct their efforts towards developing pupils' creativity and independence in the

educational process. This is one of the ways it will be possible to activate pupils, leading them to develop creativity and analytical-critical thinking. One of the results will then be the development of pupils' independence and self-assessment skills. The above aspects are essential for the readiness of pupils and students for the challenges of the current and dynamic working environment.

We have divided the research conducted in the extension study over ten years into nine areas based on the aspects under study (Scheme 1). Dividing the survey into these areas helped us structure and present the results clearly and navigate the material.



Scheme 1: Areas of inquiry and their distribution for extension studies (Source: Author)

4.1 The Interpretation of Respondents' Answers

We asked, "*What subject do you teach and in which grades?*" Of the 20 respondents surveyed, 80% answered that they work as teachers of science subjects, including chemistry. 20% of the respondents surveyed taught the following subjects: civics, history, art, occupational education, or were on maternity leave. Many of the respondents have worked or are working as teachers in primary schools and teach all grades of lower secondary education within the Human and Nature educational area.

The following item asked, "*What reasons led you to study chemistry?*" Respondents' answers are summarised in Table 1.

Table 1: Respondents' answers to the question, "What reasons led you to study chemistry?"

Reasons	Respondents' answers
Personal interest:	Knowledge related to the subject of chemistry was a motivation for them. The pupils were often motivated to continue their studies through further education oriented towards the Chemistry Teacher Training Programme (combined).
Professional training:	The study of chemistry provides teachers with professional training in the discipline. With sufficient knowledge of chemistry, they will be able to teach the subject effectively to their pupils, providing them with a comprehensive and quality education.
Expanding and updating knowledge:	Chemistry is not only a natural science but a particularly dynamic discipline with constant development and innovation. Studying chemistry allows teachers to keep their knowledge up to date. They can also keep abreast of discoveries and trends in chemical science and pass them on to their pupils.
Innovative teaching:	Chemistry is an experimental science and can be a subject that is greatly enriched through experiments, hands-on demonstrations, and interactive teaching methods. Studying chemistry allows teachers to integrate innovative and engaging approaches into their teaching, increasing student interest and engagement.
Fostering critical thinking:	Chemistry as a science requires problem-solving skills. Solving them relies on critical thinking and analytical skills. Studying this discipline helps teachers develop these skills in their students, which positively impacts their learning and overall academic development.
Practical applications:	Chemistry has many practical applications in various sectors, such as healthcare, industry, environment, etc. The chemistry study provides teachers with a deep understanding of these applications, allowing them to better connect theoretical knowledge with practice for their pupils.

(Source: author)

A summary of the respondents' answers led us to the following conclusions about the study of chemistry:

- *strengthens teachers' expertise,*
- *contributes to their ability to innovate teaching materials,*
- *supports the development of pupils' critical thinking skills,*
- *leads to the acquisition of practical skills.*

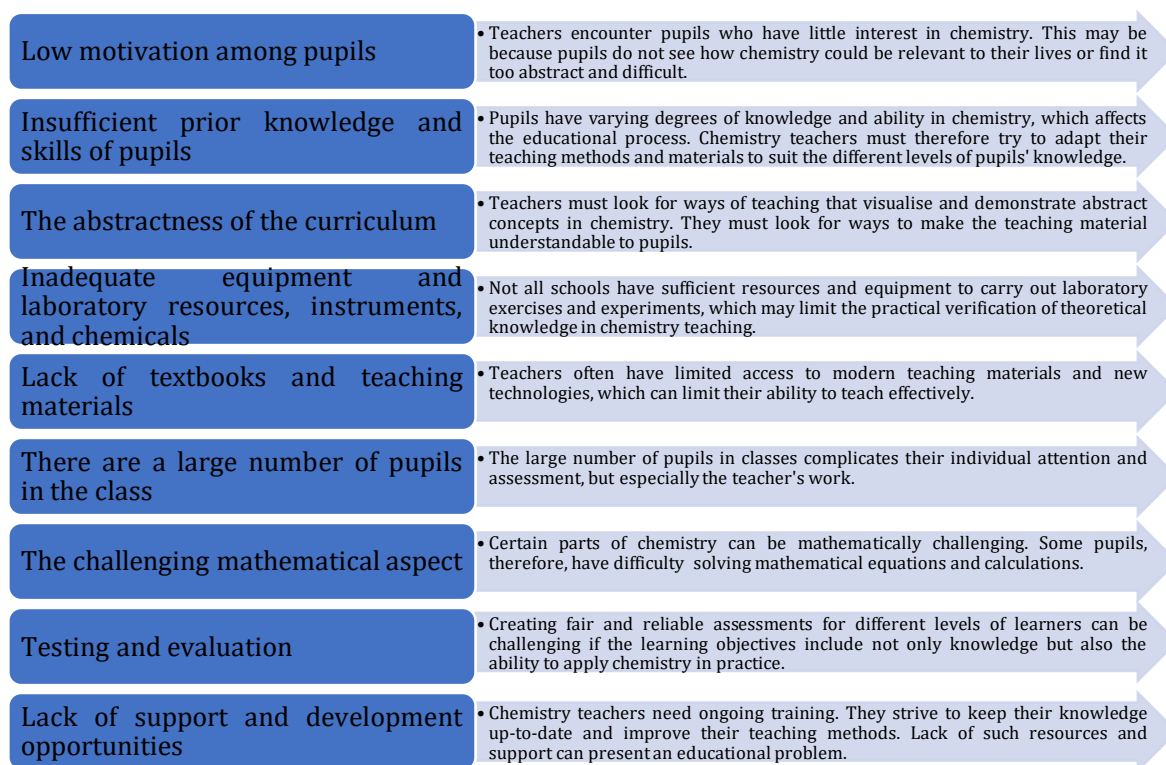
In addition to attractiveness, the fundamental factors include the motivation to choose a profession through studying to meet the qualification requirements, while the overall motivation is intrinsically specific and differentiated (Kolar & Verešová, 2022, p. 81).

The item "What is the staff-professional representation for teaching chemistry, i.e., how many chemistry-qualified teachers are working at your school?" was of interest to us to find

out the actual situation in the schools where the respondents work. Many responses were that one chemistry teacher is working in that school. 20% of the respondents answered that none of the teachers they worked with qualified in chemistry.

For the question, "What is the average number of pupils in classes where chemistry is taught?". The respondents answered that the number of pupils is 15 or more, and only one respondent taught in grade 9, where there were 13 pupils. Since chemistry is an experimental science, we asked the respondents whether the school has suitable material and technical conditions and whether laboratory exercises are part of the chemistry subject. Of the 20 respondents interviewed, 7 confirmed that the chemistry subject also has laboratory exercises to acquire and test pupils' practical skills.

Respondents consider the following to be the most common problems in teaching practice (Scheme 2):



Scheme 2: Missing factors in the educational process (Source: Author)

As Kolar and Verešová (2022, p. 81) state, "There are three reasons why there are fewer and fewer new teachers: recruitment problems (problems with finding a job), problems related to burnout (many teachers leave after a short time), and low motivation (low interest of students in studying teaching)."

A teacher should have a thorough knowledge of his or her field, good pedagogical training, social-character qualities, and competencies for a well-conducted educational process. Solving these problems requires creativity, patience, and cooperation between teachers, schools, educational institutions, and parents.

Teachers' competencies related to the educational process are as follows:

- *professional competence*: competencies acquired based on pedagogical, psychological, and didactic training.
- *performance competence*: working ability conditioned by physical and neuropsychological ability to cope with work stress.
- *personal competence*: social maturity, appropriate character qualities, and will.
- *social competence*: moral qualities of the teacher as a bearer of specific values; by his or her actions, he or she should be a social model for others.
- *motivational competence*: identification with the role of a teacher and commitment to its fulfilment (Dytrtová & Krhutová, 2009).

Kolar and Verešová (2022, p. 81) state that a better understanding of the motives for choosing to become a teacher and why interest in teaching has declined should initiate steps leading to increased interest and improve the attractiveness of teaching.

In the following items, we make some general suggestions that could help improve chemistry teaching in primary schools. Respondents were asked for *suggestions on improving chemistry education and what they see as the main reasons for low pupil motivation*. (Figure 1).

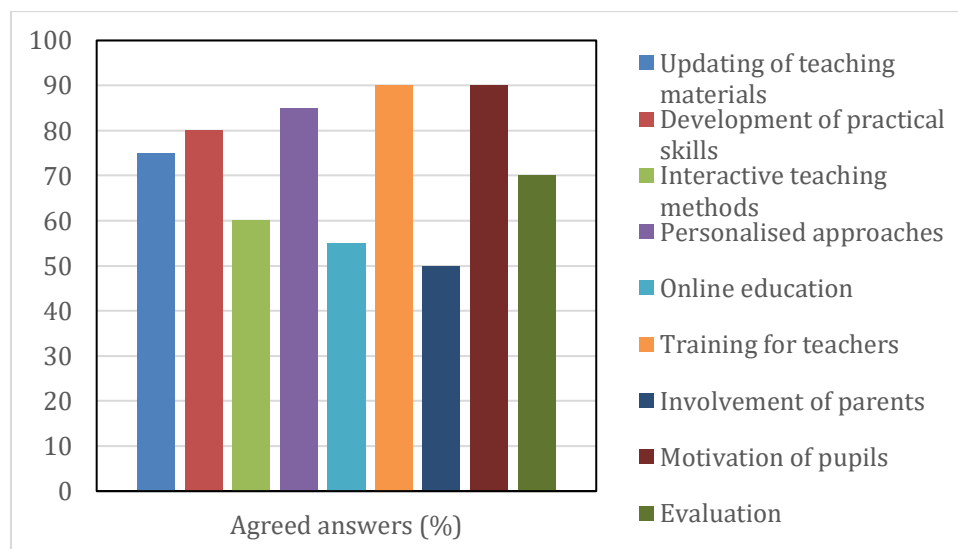


Figure 1: Suggestions of respondents for improving chemistry education in schools

The above suggestions are in response to the problems that educators encounter in teaching chemistry in schools, and their solutions are as follows:

They see *the updating of teaching materials* in the provision of up-to-date teaching materials and textbooks that are relevant to the current state of the art in chemistry. Increasing the emphasis on practical exercises and experiments in the laboratory to help pupils better understand chemical processes, reactions, etc. will also influence *the development of practical skills*. Use of *interactive teaching methods* that actively involve pupils in the teaching process (discussions, group work). *Individualised approaches and support for pupils* should be based

on giving pupils the opportunity to choose from a range of activities on offer (e.g., chemistry club) according to their interests and abilities in chemistry. Create environments to support and develop pupils' knowledge (consultation with teachers) and tutorial support.

Offering *online courses or learning materials* will ensure flexibility in teaching. Ensuring *teachers have access to training* and opportunities to expand their knowledge and teaching methods. As stated by Verešová et al. (2023, p. 43), nowadays, teachers must invest in their professional and career development because society is constantly changing and evolving. Encourage interest in chemistry and learning in the home environment and involve *parents*. Applying chemistry knowledge to real-life practice, such as talks or meetings with chemistry staff in schools, as *motivators for pupils*. *Evaluation* is grounded in the understanding of the learning material, thus ensuring improved ways of assessing and giving feedback to pupils.

Answers to the question of why there is *a shortage of chemistry teachers* in primary, secondary, and high schools and what this is related to were as follows:

- the difficulty of quality vocational training in chemistry may be a barrier,
- the reason is the changes that are taking place in the chemistry curriculum and requirements, which may affect the interest of prospective student teachers in studying the subject of chemistry,
- lack of chemistry teachers may also be influenced by the region (geographical, social, or economic factors) Perignáthová (2019),
- according to Perignáthová (2019), teachers are often also affected by a lack of career development opportunities or low salaries compared to other professions.

Based on the results, a survey aimed at finding solutions to increase the number of chemistry teachers proved that this problem is solvable. For example, further training in the form of extension studies is an option. The interpretation of the results of the questionnaire survey confirmed that the method used is effective for obtaining relevant data.

It is very important to keep track of all relevant supporting information and then focus on solving the problem. To improve the training and shortage of chemistry teachers in schools, it is an important step to find out the causes. The next steps in addressing this problem should include the status of the teacher shortage, the causes and consequences of low teacher numbers, teacher recruitment and motivation, teacher training, and support and professional development for chemistry teachers.

5 Conclusion

The number of teachers in schools is declining as a result of rising demands on them. Constantine the Philosopher University in Nitra's Department of Chemistry educates pre-service chemistry teachers, setting the stage for the training of competent educators who will lay a strong basis for education for the coming generation. This can be seen by looking at a synopsis of the study programmes offered within the context of education at the Department of Chemistry. Nonetheless, we should pay attention to the problem of the dearth of

chemistry-qualified teachers in schools. The scarcity significantly impacts the young generation's education, growth, and other interests. Despite the value and rising interest in chemistry education, there is a severe lack of skilled chemistry teachers in schools. As a result, we must consider this problem and come up with solutions. Simultaneously, curriculum development and funding should be prioritised to inspire pupils to pursue science courses, including chemistry. Access to laboratories, hands-on learning opportunities, and professional educational resources can pique young people's interest in chemistry and subsequently provide a pool of trained educators.

We determined the causes of the scarcity of chemistry teachers based on our survey results. In the context of the discussion, we also put out some possible fixes and actions that might help improve things. A detailed examination of the entire issue and the development of a change process roadmap are necessary to address the scarcity of chemistry teachers in educational institutions. Together, we should explore strategies to raise the appeal of teaching chemistry to students and pique in-service teachers' interest in the scientific chemistry discipline.

References

- Predanocyová, Ľ., Jonášková, G. & Jakubovská, V. (2016). The objectives of education in the context of civics-competence of teacher. In *3rd International Multidisciplinary Scientific Conference on Social Sciences and Arts SGEM 2016* (pp. 1159-1166).
- Mashrabjonovich, O. J. (2023). Formation of Professional Competence of the Future Teacher in the Information and Educational Process. *Central Asian Journal of Social Sciences and History*, 4(2), 107–111.
- Perignéthová, M. (2019). Atraktivita učiteľského povolania. Inštitút vzdelávacej politiky. Ministerstva školstva, vedy, výskumu a športu SR (online). 24 p. Available on: <https://www.minedu.sk/data/att/25036.pdf>
- Enina, O. (2023). Prerequisites and factors of sustainable development through introducing innovative technologies in education. In *E3S Web of Conferences* (Vol. 371, p. 05020). EDP Sciences.
- Pramana, C., Chamidah, D., Suyatno, S., Renadi, F., & Syaharuddin, S. (2021). Strategies to Improved Education Quality in Indonesia: A Review. *Turkish Online Journal of Qualitative Inquiry*, 12(3).
- Romanyshyn, Y., Sheketa, V., Pikh, V., Poteriailo, L., Kalambet, Y., & Pasiaka, N. (2019). Social-communication web technologies in higher education as means of knowledge transfer. In *2019 IEEE 14th International Conference on Computer Sciences and Information Technologies (CSIT)* (Vol. 3, pp. 35-38). IEEE.
- Simonova, O., Barashyan, V., Gampartsumov, A., & Khlebnikova, M. (2021). The application of reality simulators for improving the quality of education at universities. In *E3S Web of Conferences* (Vol. 273, p. 12081). EDP Sciences.
- Kopas-Vukasinovic, E. (2014). Student Initiative in the Classroom as a Prerequisite for the Development of University Education System. *Some Current Issues in Pedagogy*, 37-50.

- Renz, A., & Hilbig, R. (2020). Prerequisites for artificial intelligence in further education: Identification of drivers, barriers, and business models of educational technology companies. *International Journal of Educational Technology in Higher Education*, 17(1), 1-21.
- Fischer, G., Lundin, J., & Lindberg, J. O. (2020). Rethinking and reinventing learning, education, and collaboration in the digital age—from creating technologies to transforming cultures. *The International Journal of Information and Learning Technology*, 37(5), 241-252.
- Santos, G., Marques, C. S., Justino, E., & Mendes, L. (2020). Understanding social responsibility's influence on service quality and student satisfaction in higher education. *Journal of cleaner production*, p. 256, 120597.
- Act of the National Council of the Slovak Republic No. 138/2019 Coll. on pedagogical and professional staff and on amendment and supplementation of certain acts.
- Kolar, M., & Verešová, M. (2022). Analýza motívov k voľbe učiteľského povolania u učiteľov v pregraduálnej príprave na Univerzite Konštantína Filozofa v Nitre. In *Konvergenie vedeckej činnosti študentov a učiteľov III*. PF UKF Nitra, 238 p.. ISBN 978-80-558-1902-0.
- Dytrtová, R., & Krhutová, M. (2009). *Učiteľ - príprava na profesii*. Grada Praha, 128 p. ISBN 978-80-247-2863-6.
- Verešová, M., Rapsová, L., & Krause, R. (2023). *Osobnosť a motivácia k voľbe povolania ako prediktory profesijných kompetencií učiteľov v pregraduálnej príprave a v praxi*. PF UKF Nitra, 192 p. ISBN 978-80-558-2049-1.