



WHAT PRE-SERVICE CHEMISTRY TEACHERS KNOW ABOUT STEM EDUCATION METHODOLOGY

Nijolė Cibulskaitė¹, Małgorzata Krzeczowska², Agata Augustynovič³

¹Vytautas Magnus University, Lithuania (*nijole.cibulskaitė@vdu.lt*)

²Jagiellonian University in Kraków, Poland (*malgorzata.krzeczowska@uj.edu.pl*)

³Vytautas Magnus University, Lithuania (*agata.augustinovic@stud.vdu.lt*)

Abstract

In order to solve the problems of the 21st century, it is necessary to apply the knowledge of many fields of science and combine their ideas. Chemistry is one of the fundamental science subjects taught at school, the teaching of which consists not only of teaching-learning theory but also of practical laboratory activities. Active involvement of the students in learning is very important for successful chemistry teaching, therefore active, learner-centred teaching strategies are recommended. Chemistry educators looking attractive methods and forms of work as well as teaching aids. The research problem presented in this article poses the question: which elements of STEM methodology are used by pre-service chemistry teachers and what they think should be used during chemistry lessons in the future? The pre-service teachers taking part in the survey are convinced that the use of STEM methodology is productive and effective in the teaching process. Teachers believe that students' general competences need to be developed on the basis of authentic life contexts and the intellectual activity of a student. In their opinion, STEM education enables students to use their previous knowledge and experience, it gives them time for analysis and reflection.

Keywords: STEM education; chemistry; pre-service teacher.

1. Introduction

For many years, science subjects have not been popular subjects for future professional studies [1], so there is a need not only to popularize science subjects, but also to teach students to work independently and creatively in them. Without subject motivation, the teacher's effort to approach students creatively is futile and unnecessary. Therefore, it is the duty of every teacher to look for new opportunities and ways to popularize the field of natural sciences, mathematics, and engineering. One possibility is to use teaching methods with a high motivational load, both traditional and completely new, in teaching.

New didactic solutions concern various aspects of the process of chemistry education. Teaching and learning chemistry can take various organizational forms, and the variety of these forms is conditioned by many factors, for example, the goals of education, the structure and content of the classes. As a form of the organization of school work, lessons should be considered together with its content and the purposeful activity of the teacher. Although currently the role of the teacher is changing, it is still the teacher who is largely responsible for the course of the educational process in the classroom [2].

STEM approach to education focuses on the change based on human resources and society development [3], therefore STEM ideas are becoming one of the major trends in global education. The perception of STEM education by teachers is very important considering the fact that they can influence the development of STEM school education. To promote STEM education, this survey aims to identify the teachers' implementation of STEM ideas in state schools.

The majority of STEM education initiatives aim to make STEM fields and careers interesting and attractive to students [4]. However, there is an urgent need to train STEM teachers before and during their STEM teaching so that they can successfully introduce different STEM subjects into their lessons. In order to have STEM class implemented, teachers must have certain skills and knowledge to integrate technology and engineering concepts into classroom practice [5]. This results from the modification of educational requirements as well as the expectations and predispositions of the learners [6]. According to researchers, teaching strategies are important for an effective educational process [7]. They must be applied in a purposeful, planned and systematic way. The teacher must take into account the educational



goals, as well as other factors: the school subject, the abilities of the learners, the age of the learners and learning environment when planning the educational process and choosing the appropriate teaching strategies and teaching tools [8]. The teacher should be characterized by a flexible style of work that changes and adjusts the methods of work and the scope of the material to the needs and interests of a student. This should be manifested in taking into account the intellectual abilities of the learners and in appropriately adapting one's interactions to them. The teacher's role is to facilitate the acquisition of knowledge by the students, and when selecting teaching methods and didactic resources, they should remember about the diversity of learning styles, way of thinking and personalities of the students [9]. The conditions for the successful acquisition of knowledge for all learners should be created by the teachers.

Teachers' professional development generally focuses on the acquisition of pedagogical content and methodology knowledge. However, the change occurs when teachers feel confident enough to put their new knowledge and skills into practice. Therefore, the professional development of teachers is increasingly seen as teacher's empowerment [10].

2. Methodology

The method employed in the study was a diagnostic survey using a questionnaire developed by the authors. The survey was conducted in the form of an online version, which included six questions: two single-choice closed questions with four answers according to Likert scale, three closed ones with multiple answers to choose from, and one with open questions.

The Faculty of Chemistry of Jagiellonian University in Kraków gives the opportunity to obtain the qualification to teach chemistry at school by starting students' participation in pre-service training. The survey was conducted at the end of spring semester in 2021 academic year; a questionnaire sent to 44 pre-service chemistry teachers, all the participants replied. In winter semester of that year, pre-service teachers participated in seminars the topics of which were dedicated to formal and informal preparation for chemistry lessons, e.g. lesson plans, didactic methods and strategies, didactic tools and additional materials.

3. Results

In order to analyse the research data, measures of descriptive statistics were applied. In the text below, the word „teacher“ means pre-service student and the word „student“ means school student (pupil). The authors chose to analyse four survey questions.

Question no.1: According to the given 11 examples of statements, please indicate three most important, which in your opinion should be used during chemistry lessons. Teachers found the following ways of applying STEM methodology to be the most useful:

- more than a quarter of the respondents (26%) noted that students' general competences need to be developed on the basis of authentic life contexts and the intellectual activity of the student. It is known that this approach influenced positively the learning outcomes or led to better learning outcomes [11];
- one-sixth of the respondents (17%) believe that STEM education enables students to use their previous knowledge and experience, it gives them time for analysis and reflection;
- one-eighth of the respondents (13%) think that it is important to use active teaching methods in the classroom; STEM is a process-oriented teaching that focuses on active learning and independent acquisition of knowledge, and teacher regulates student's cognitive processes through appropriately applied teaching methods;
- the collected data shows that lesson topics should be associated with current ecological problems, connected with environmental protection, latest scientific and economic information – it is important for more than one-tenth of the respondents (11%). STEM is associated with new inspiring works: exploration and protection of nature, technical, medical and economic discoveries; it also allows for the development of the students' cultural sensitivity, showing its importance;
- for one-tenth of the respondents (10%) it is important to ensure that students can learn to do research, evaluate and analyse the collected data in their classes.



Only 7% of respondents know that it is important to give students a chance to develop their competences and STEM methodology actively helps to develop the 21st century skills; unfortunately only a few respondents (5%) also know how important it is to teach chemistry in cohesion with other school subjects.

Question no.2: Please indicate at least three statements that you used during your chemistry lessons. Statements like „You present the contents introduced during the lesson in connection with daily life” and “You ensure that students use prior knowledge and experiences” have the largest number of indications (22%). The use of active methods is another most popular statement (14%).

It may not be worrying that statements: “You use IT components during the lesson” (6%) and “As you teach, you make use of field trips and scientific excursions” (7%) have the least number of indications. On the other hand, both lessons were conducted in a remote version, which apparently was treated as something normal at that time.

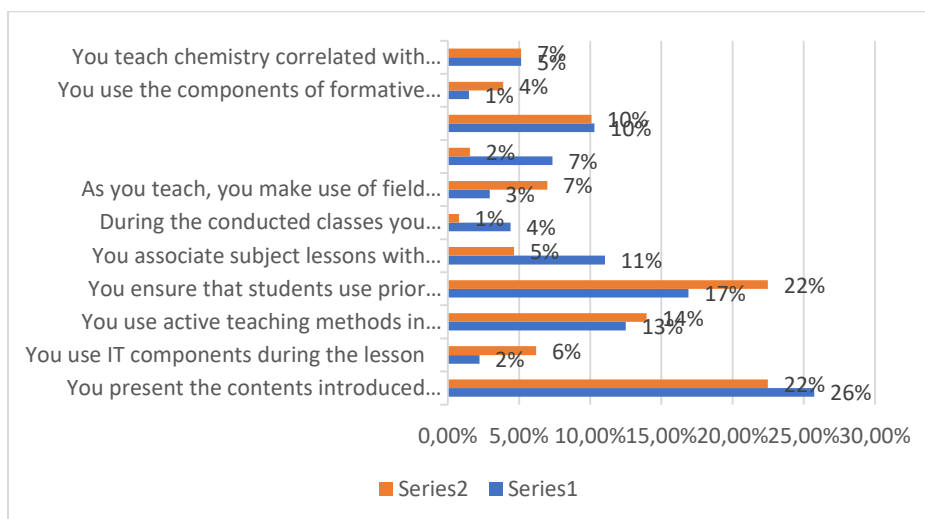


Fig. 1. The comparison of the frequency of selection of various statements under question Q.1 (Series 2) and Q. 2 (Series 1)

The results from the question Q.1 and question Q.2 are compared in the Fig. 1. The results presented in Figure 1 show that according to the respondents, lesson topics should be associated with the current problems connected with environmental protection, latest scientific and economic information, but during their lessons it is not important. A similar situation applies to giving the students a chance to develop their 21st century competencies. We suppose that the result is due to the fact that only two lessons were conducted.

Question no.3: How often do you use /do you perform the following activities in your lesson plan or conducted lesson at school? Likert scale appeared in this question: always, often, seldom, never. A survey was carried out to collect opinion about a teacher's strategy and activities while conducting lessons, how often they were or will be doing activities to facilitate learning, which activities can help teachers to raise student's motivation. An important aim of the study was to determine how often teachers fulfil their motivating role in order to make students interested in chemistry at school [12], because students do not always see chemistry as important and valuable in society, and they declare that the theory itself as well as abstract science itself are demotivating factors.

The survey shows that almost two-thirds of the respondents (64%) often provide students with knowledge and help to develop the skills necessary to live in a changing environment, they indicate the usefulness of the acquired knowledge in everyday life and in professional activity. Significantly more than half of the respondents (61%) often achieve the goals of the lesson, which are based on the content related to various practical actions of a human. More than two-thirds of the teachers (68%) often collaborate with colleagues, discuss with them how to implement a lesson plan (which introduces a problem related to the content and skills acquired in the previous lessons), but half of the respondents (52%) rarely collaborate with colleagues when planning a lesson and looking for content integration. More than half of the



respondents (59%) always activate the experiences and skills of students, which they acquired at the previous stage of their studies or in other subjects - they refer to students' previous knowledge, not only in the field of chemistry. As many as half of the surveyed teachers (50%) always encourage students to use various sources of information and they often use the problem-based method that allows to solve a problem based on an experiment, and shape the research attitudes of students.

Another aspect focused on the development of effective learning is the organization of the teaching process [13]. The teachers' declarations show that when implementing the chemistry curriculum, they take into account the activities that evoke positive feelings and strengthen motivation. Almost half of the surveyed teachers (46%) often implement educational projects, because they want students to be active and interested, to act and talk more than the teacher, conduct experiments and come to their own conclusions.

Based on the next question, we want to figure out the teachers' opinion about some new elements / actions which were taken into account when planning lessons and realising the curriculum (Q.4). The collected data shows that educational project method is the most commonly used. Scientific exhibitions and researchers' festivals also appeared as important part of the implementation of the curriculum. It is very promising that almost all the respondents know how important role educational project method plays in teaching and learning process. It is worth integrating chemistry with other school subjects and developing students' research attitude and skills.

4. Conclusions

Any type of integration requires planning, and teachers need time to organize close collaboration with colleagues to make their creative endeavours effective and fruitful. From the analysis of the results obtained, it can be concluded that it is worth suggesting to teachers that when introducing STEM methodology in the classroom, they should focus on the creative connections between the subjects.

According to the teachers, STEM strategies in chemistry lessons allow for the solution of real global problems through place-based learning and inquiry learning. Teachers are motivated by the implementation of these strategies, because they want students to get to know a given field, i.e. chemistry, as much as possible, not only theoretically, but also practically, and that students should look for and see as many applications in everyday life as possible.

The survey results indicate that some elements of STEM methodology were intuitively applied in the classroom by pre-service teachers without knowing the basics of this methodology. Only elements of problem based learning and IBSE methodology appear explicitly in curriculum of pre-service training [14].

The majority of the surveyed pre-service teachers emphasized that STEM methodology allows them to combine science subjects, to look at chemistry issues in a wider perspective, what stimulates problem-solving and facilitates the assimilation of the content [15].

Most of the surveyed teachers see the point in the implementation of STEM methodology in the classroom. According to the respondents, it makes sense to relate the content to the student environment, but these ideas are not yet appreciated by future chemistry teachers.

This pilot study should be continued after finish by teachers a long-term internship at school.

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