IMPLEMENTATION OF PRACTICAL WORK IN CHEMISTRY IN SLOVENIAN LOWER SECONDARY SCHOOLS: MORE EFFECTIVE CHEMISTRY LESSONS

DOI
https://doi.org/10.18690/um.pef.2.2024.15

ISBN
978-961-286-899-4

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Practical work in the school environment as a teaching method has many advantages, as it is more efficient due to the permanence of knowledge. The performance of practical work by students facilitates and improves logical thinking, critical thinking, understanding of science, application of knowledge, interpretation of observations and definition of a new problem. The article describes the proven benefits of practical work in lower secondary school chemistry lessons and highlights teachers' views on doing practical work and teachers' views on students' perceptions of practical work. We also looked for possible statistically significant differences in the implementation of practical work in chemistry lessons according to teachers' gender, teaching profession and seniority. Despite the importance of practical work, in practice teachers often encounter the problems discussed in the study. According to our results, teachers carry out practical work to a large extent despite the obstacles. Because of the advantages of practical work, teachers would like to have smaller groups when carrying it out, more hours for carrying it out and the support of laboratory assistant, which is common in secondary school but not in lower secondary school.

Keywords:
attitudes,
effective learning,
hands-on skills,
laboratory work,
teachers´ opinions

University of Maribor Press

DOI
https://doi.org/
10.18690/um.pef.2.2024.15

ISBN
978-961-286-899-4

Ključne besede:
laboratorijsko delo,
mnenja učiteljev,
odnos,
praktične spretnosti,
učinkovito učenje

IZVEDBA PRAKTIČNEGA DELA PRI KEMIJI V SLOVENSKIH OSNOVNIH ŠOLAH UČINKOVITEJŠI POUK KEMIJE

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Praktično delo v šolskem prostoru ima veliko prednosti pred ostalimi metodami dela, saj je zaradi trajnosti znanja, učinkovitejše. Izvedba praktičnega dela učencev vpliva na lažje in boljše sklepanje, kritično mišljenje, razumevanje znanosti, uporabo znanja, razlage opažanj ter definiranje novega problema. V članku so zapisane dokazane prednosti praktičnega dela pri urah kemije v osnovni šoli, izpostavljeni pa so pogledi učiteljev na izvedbe praktičnega dela ter mnenje učiteljev o tem, kako učenci dojemajo praktično delo. Preverili smo tudi morebitne statistično značilne razlike o izvedbi praktičnega dela pri urah kemije glede na spol, pedagoški naziv in dobo službovanja med učitelji Kljub pomembnosti praktičnega dela, učitelji v praksi pogosto naletijo na težave, obravnavane v raziskavi. Glede na naše ugotovitve učitelji praktično delo, kljub oviram, izvajajo v veliki meri. Zaradi prednosti praktičnega dela bi si učitelji želeli manjše skupine pri izvedbi, več ur za izvedbo in pomoč laboranta, kar je v srednješolskem prostoru praksa, v osnovni šoli pa ne.

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1 Introduction

In Slovenian elementary school, scientific content is woven into various subjects in all nine school years. Chemistry is a subject in the 8th and 9th grade of lower secondary school. It is a fundamental natural and experimental science in which substances, their structure, properties and changes are examined. In lower secondary school, the focus of chemistry is primarily on the acquisition and development of basic chemical knowledge, skills, attitudes and attitudes. The general aims of the lessons are for students to develop an understanding of natural processes, a responsible attitude towards handling substances and an awareness of safety in the workplace. Special emphasis is placed on developing students' experimental and inquiry skills and abilities, exposure to scientific processes, creativity, cognitive processes and critical thinking that strengthen scientific literacy. The curriculum also includes the development of scientific and mathematical competencies that promote the development of complex and critical thinking. The competencies are developed by students through searching, processing and evaluating data, using specialised terminology in describing processes, laws and phenomena, and developing an experimental approach to research (Bačnik, 2011).

As we can see from the review of curriculum content and objectives, practical work is a necessary part of science education. During practical work, students train various skills and develop many scientific competences that are necessary for life (Špernjak and Šorgo, 2018). Once you go into practise, you can understand the content better (Lau et al., 2023). Almost 1200 published papers in relevant databases: Web of Science, Education Resources Information Center (ERIC) and Scopus, in the period from 1995 to 2020, enhance the importance of chemistry laboratory work in the classroom (Ferk Savec, and Mlinarec, 2021).

Practical work gives students the opportunity to come into direct contact with materials or data that they have acquired through their own work. The teacher can carry it out to confirm what is already known (by working according to precisely prescribed procedures), or involve students in formulating questions, planning research and producing works (Gmajner, 2012), thus developing higher cognitive levels. All knowledge and theories in science come from practical observations and experiments, so hands-on work is an important part of science/chemistry teaching (Jones et al., 2016). Experimental work is indispensable in chemistry lessons because it combines several activities with different objectives (Ferk Savec, and Mlinarec, 2021).

Experts have described four types of learning in the laboratory:

> explain, explore, discover and problem solve. These are categorised by three descriptors: outcome achieved, process used, and outcome achieved (Mbajiorgu and Reid, 2006). In particular, the explanatory and problem-solving laboratory methods use a deductive approach, while the exploratory and discovery learning methods use an inductive approach. One method that students often use when learning in the lab is the expository method (Copriady, 2015; Domin, 1999). Due to the lack of time for student laboratory work (Seid et al., 2022), teachers often use demonstrations, which are also hands-on work, but students are deprived of developing many skills.

The importance of practical work in the classroom

Practical work in the context of activities gives students experience of independent work. Practical work allows students to participate in activities related to science, but also to observe, reflect, develop ideas and develop skills (Oezdemir et al., 2011). According to Šorgo (2005), practical work is irreplaceable for science education. He believes that through practical work one can achieve an understanding of many processes and many goals that are more difficult or impossible to achieve with other working methods. The experience of the pandemic underlines the perceived importance of practical work in science education (Lau et al., 2023). Practical work requires more sensorimotor involvement from students than listening (Šorgo, 2005), so practical work can be more effective in terms of knowledge sustainability compared to other forms of work. In practical work, which takes place on an individual basis, interaction between teacher and student is also more frequent (Šorgo, 2007).

Practical work impacts on reasoning, critical thinking, understanding of science, development of skills and manual dexterity and enables students to apply knowledge, define a new problem, explain observations and make decisions. Students can actively participate, observe and evaluate the results of practical work, which makes learning permanent (Kolçak et al., 2014).

Integrative refers to the integration of theory in the classroom and practical application in the laboratory; efficient and practical indicates that the practicality of economic and simple practice; training skills include practical skills, transferable skills and intellectual stimulation (Anwar et al., 2024). Practical work also enables the student to learn about different concepts such as theoretical models, hypotheses and taxonomic categories. Cognitive skills such as problem solving, analysis, synthesis, application and critical thinking are an important goal that students can achieve through practical work. Through hands-on work, students also gain an understanding of the nature of science, such as the work of a researcher, the connection between science and technology, scientific wonder, and the existence of different scientific methods. An important goal is also to adopt attitudes such as objectivity, curiosity, accuracy, risk acceptance, doubt, satisfaction, consensus, collaboration, responsibility and enjoyment of scientific work (Šorgo, 2005). Practical work in the scientific subjects is also important because it promotes creativity. With the help of practical work, the student can develop self-confidence, the ability to work according to instructions and memorise facts and principles more easily (Šorgo, 2007a). Teachers should be aware of the benefits of practical work for students. Although we can see from the comments of teachers from our research that they see benefits in practical work, the challenges and problems are obviously so great that they outweigh the benefits. Based on the facts:

- that practical work is necessary for the development of understanding of scientific concepts and explanations (Toninato and Santovito, 2015)
- that practical work enables students to better connect theory with practice and thereby also acquire life skills (Šorgo, 2005);
- that learning is more sustainable through student activity (Kolçak et al., 2014);
- that methods in which students are active and independent increase students' interest in scientific content (Itzek-Greulich et al., 2017)
- that students develop many practical skills during hands-on work (Jones et al., 2016) and that practical work should be carried out in such a way that the students acquire skills and competencies for their future lives to the greatest extent possible.
- When a student's achieves something on their own, completes a certain task, they feel satisfied. Students' interest in science subjects is greater in subjects

that are related to everyday life and involve a lot of practical work (Itzek-Greulich et al., 2017).

Laboratory work - practical work is crucial in science / chemistry education, but teachers still encounter problems in practise. One of the main problems is that schools do not have sufficient equipment; the teacher needs more time to conduct lessons using experimental methods; students waste time collecting data; teachers' concern to fulfil the goals of the subject from the curriculum. School laboratories usually do not have the necessary equipment, so teachers either do not conduct experiments or the experiments are performed as demonstrations in class. Since teachers often do not receive enough information and skills during their training, they do not even bother to conduct experiments, especially when they encounter inadequately equipped laboratories (Kolçak et al., 2014).

Despite the proven importance of laboratory work in basic education, teachers are not unanimous the usefulness of practical work in the educational process. Some do not see the pedagogical benefits of practical work. On the other hand, there are many who see practical work as necessary. Practical work should be a puzzle and not the land of the already known (Lagowski, 2005).

Practical work in chemistry

Previous studies have reported that teachers perceive the inclusion of a list of recommended experiments for science lessons as positive (Gudyanga and Jita, 2019). Seid et al. (2022) surveyed teachers on factors that impact the practice of working in the chemistry lab. Teachers reported lack of resources (62%), lack of student interest in lab work (42.6%), lack of time for lab work (40.3%), lack of student participation in lab activities (36.6%), and that grading of lab reports is not encouraging (36.1%). When asked what problems they face when conducting laboratory work, most teachers agreed that it is difficult to conduct experiments in a context where there are not enough resources available. Considering the importance of practical work in chemistry lessons, it would be good to know the picture in Slovenian schools.
The aim of the research was to determine:

(i) How Slovenian chemistry teachers perceive students' experiences of practical work

(ii) Teachers' views on the implementation and purpose of practical work in lower secondary school chemistry and

(iii) whether teachers' implementation of practical work differs and is statistically significant due to demographic differences (gender, age, seniority, title, school location).

2 Methods

2.1 Questionnaire

For the study, we used a questionnaire consisting of three parts. The first part contains questions about practical work in chemistry classes (e.g. how often they do laboratory work, what form of laboratory work they usually use, whether they have a laboratory assistant. According to the official Slovenia website Državni portal za poslovne subjekte (https://spot.gov.si/sl/dejavnosti-in-poklici/poklici-in-strokovni-kadri/laborant-v-vzgoji-in-izobrazevanju/), laboratory assistant in education conducts laboratory exercises, assists the subject teacher in class and prepares laboratory exercises, prepares materials and other didactic aids for conducting exercises and conducts other forms of organized work with students.).
The second part consists of general questions about practical work, in which the teachers surveyed indicate their level of agreement with each item (see results in Table 1). The last set contains demographic questions (gender, age group, number of years teaching the subject, title, other subjects taught).

2.2 Sample and sampling

We used the 1ka online survey (https://www.1ka.si/). We sent the survey by e-mail to all 781 Slovenian elementary school, of which 456 were mainstream schools and 325 were branch schools. The research sample included chemistry teachers. The survey was active from April 25 to July 25, 2021. The survey was anonymous, so it is impossible to determine who completed the survey. We only asked the teachers which region the school they teach in belongs to. We rely on the honesty of the teachers and believe that no one would fill out the same survey more than once.
The questionnaire was fully answered by 98 respondents, which corresponds to about 21% of Slovenian chemistry teachers. Depending on:

- gender: 5 (5.10%) men and 92 (93.90%) women.
- we divided them into three categories according to age:
  a) 10 (10.20%) teachers between the ages of 24 and 35 participated,
  b) 44 (44.90%) teachers were between 36 and 50 years old,
  c) 44 (44.90%) of the respondents were older than 51 years.
- 11 (11.20%) of the respondents had no title, 16 (16.30%) had the title of mentor, 47 (48.00%) had the title of advisor, 19 (19.40%) had the title of councillor, and 5 (5.10%) of the respondents had the title of senior councillor.

Of the 98 respondents, 95 (96.90%) teachers teach 8th grade chemistry and 97 (99.00%) teach 9th grade chemistry.

When asked whether they have assistant to assist them with laboratory work, 60% of the teachers surveyed answered yes.

The participating teachers not only teach chemistry, but also other subjects.

2.3 Statistical analyses

A total of 98 chemistry teachers responded for the subject of. We processed the collected data with a descriptive analysis using the statistical programme IBM SPSS 26.0. The results are described and presented in the form of tables. We included frequencies and proportions of responses, mean values ($\bar{X}$) and standard deviations (SD) in the analysis. The reliability of the questionnaires was checked using the Cronbach's α value, which is 0.53 for the chemistry questionnaire, which is generally low but still sufficient for further data processing.

We used the Kruskal-Wallis Test to analyse the differences according to the teacher's job title and seniority. For a more detailed analysis between the groups, we also used the Chi-Square test. Differences with $p < 0.05$ were considered statistically significant.

3 Results

3.1 Comparison of teachers' opinions about the experience of students' practical work with the perception of the importance of teachers' practical work

We were interested in the teachers' opinions about the students' experiences with practical work. The teachers pointed out many advantages of practical work:

- 49 (50.00%) of the teachers surveyed thought that students experience practical work as positive, as the best part of chemistry lessons, that they enjoy it, that they love it, that they like it and want it, that they adore it, that they look forward to it, and that it also motivates them because they like to work, because they like to be active, because they like to participate, and above all, because they like to experiment, because they are interested in the practical work.
- 10 (10.20%) teachers believe that the students experience the practical work as motivation and incentive for the work.
- that students experience practical work as instructive because it enables them to understand better, learn deeper, faster and easier and remember better, and at the same time practical work enables them to gain experience and develop skills, according to 7 (7.14%) of the respondents.

Teachers pointed out the content of practical work that needs special attention, namely 16 (16.3%) of teachers think that:

- practical work provides students with entertainment and a break from regular academic work, practical work is fun for students, students think that practical work is not a lesson and they do not need to know the content of this work, most students do not understand the meaning of practical work and have problems reading the instructions, students learn a lot, but sometimes they start the work with fear and then soon realize that it is interesting, the students are very interested during the practical work, but in the next lesson they do not remember what they have done, the students are uninterested because they do not carry out experiments themselves and do not get a real feeling for it, the students are very spoiled and accept the practical work worse and more superficially every year.

Six (6.12%) teachers believe that students experience practical work differently, they wrote:

- some are highly motivated, but there are more and more people for whom practical work is a great unnecessary effort; some find it exhausting, others enjoy it; individualistic students with better grades often have problems with working in groups; some like it, others enjoy it so much that they do silly things; most students enjoy experiments and look forward to them, but there are also some are afraid of matches, fire, unknown substances, most find it interesting and are well motivated, while others keep stay in the background.

Ten (10.20%) of the respondents did not answer the question on how the students experience the practical work according to the teachers.

Respondents also gave answers to the question on how they perceive the importance of practical work (advantages, weaknesses, challenges, problems, etc.). Eleven (11.22%) of the respondents did not answer the question, but 42 (42.86%) of the respondents mentioned the benefits of practical work:

- it is not just theory, it is an enrichment of the lesson; action, stimulation, activity, activation of the senses;
- deepening of theoretical content, linking theory and practice, students test theory on concrete examples or learn new material;
- good motivation;
- development of enjoyment of the subject and scientific skills; encouragement to learn chemistry;
- practical work makes chemistry interesting, familiar and exciting;
- more consolidated knowledge, students remember better and more easily; easier and better understanding of the material;

- there is no chemistry without experiments/practical experiments, because they are instructive, interesting for the students, they learn a lot through this work, acquire additional knowledge;
- students develop skills and practical abilities during experimental work
- students develop social skills, management skills, cooperation with others, precision, strengthening manual skills, developing a research approach;
- experiential learning: direct experience, the child physically feels the utensils, sees the substances, learns precision, order, cleaning;
- clarity of content;
- learning through research;
- development of critical thinking;
- greater student activity;
- linking abstract knowledge to everyday life;
- students learn to formulate hypotheses, observe, analyze, draw conclusions and predict outcomes, record results;
- loss of fear of experimentation.

Both advantages and disadvantages, challenges and problems of practical work were written down by 30 (30.61%) respondents. 15 (15.31%) respondents only wrote down the weaknesses, challenges and problems of practical work. Teachers mentioned the following disadvantages of practical work:

- practical work is time-consuming, a lot of time is invested;
- a lot of preparation is needed to ensure that everything goes well;
- some students benefit a lot from practical work, others less;
- some students do not take the practical work seriously, but see it as fun;
- everything depends on the school management
- equipping the classroom with a cupboard, lab;
- additional burden and stress for the teacher.

The teachers mentioned the following problems with practical work:

- practical work is underestimated and incorrectly assessed, as teachers usually assess the product - worksheet or report - and not the work in the laboratory;
- a (too) large group of students;
- a lab technician who is unprofessional, has no experience with hands-on work, cannot help, is shared by too many teachers, or does not exist at all;
- not enough lessons and an overcrowded curriculum;
- unsuitable classroom, inadequate equipment;
- lack of equipment, materials and chemicals;
- students have less and less developed manual skills;
- difficulties in handling glassware and chemicals and the resulting risk of injury;
- students are not yet able to link knowledge, so that additional explanations are required.

As far as practical work is concerned, teachers would like to see smaller groups of students and more chemistry lessons per week so that they can do more practical work. Around two thirds of the teachers surveyed are of the opinion that they would like to carry out more practical work than before.

Participants' views on points of laboratory work related to job title. The participants have marked their opinions with numerical values, where 1 means "I don't agree at all"; 2 – "I don't agree"; 3 – "I cannot answer"; 4 – "I agree"; 5 – "I totally agree". The results are shown in Table 1 and ordered by decreasing Pearson chi-square values (χ^2).

Table 1: Respondents' opinions on the written items about the job title ˝chemistry teacher˝.

items	career title*	frequency (N) and the answers percentages [%]					$\bar{X}$	SD	χ^2	*p*
		1	2	3	4	5				
The Slovenian workbooks are not sufficiently equipped with laboratory and experimental content.	A	3 (27.30)	2 (18.20)	1 (9.10)	2 (18.20)	3 (27.30)	3.00	1.67	9.91	0.04
	B	1 (6.30)	3 (18.80)	4 (25.00)	3 (18.80)	5 (31.30)	3.50	1.32		
	C	9 (19.10)	15 (31.90)	13 (27.70)	6 (12.80)	4 (8.50)	2.60	1.19		
	D	4 (21.10)	7 (36.80)	5 (26.30)	3 (15.80)	0 (0.00)	2.37	1.01		
	E	0 (0.00)	0 (0.00)	3 (60.00)	1 (20.00)	1 (20.00)	3.60	0.89		
Slovenian textbooks are not sufficiently backed up with laboratory and experimental content.	A	3 (27.30)	1 (9.10)	4 (36.40)	1 (9.10)	2 (18.20)	2.82	1.47	9.75	0.05
	B	0 (0.00)	2 (12.50)	5 (31.30)	4 (25.00)	5 (31.30)	3.75	1.07		
	C	9 (19.10)	16 (34.00)	6 (12.80)	12 (25.50)	4 (8.50)	2.70	1.28		
	D	5 (26.30)	2 (10.50)	8 (42.10)	4 (21.10)	0 (0.00)	2.58	1.12		
	E	0 (0.00)	0 (0.00)	4 (80.00)	0 (0.00)	1 (20.00)	3.40	0.89		
I am satisfied with the range of chemicals available at school.	A	0 (0.00)	5 (45.50)	0 (0.00)	4 (36.40)	2 (18.20)	3.27	1.27	8.76	0.07
	B	2 (12.50)	2 (12.50)	4 (25.00)	7 (43.80)	1 (6.30)	3.19	1.17		
	C	2 (4.30)	4 (8.50)	4 (8.50)	21 (44.70)	16 (34.00)	3.96	1.08		
	D	0 (0.00)	2 (10.50)	5 (26.30)	9 (47.40)	3 (15.80)	3.68	0.89		
	E	0 (0.00)	1 (20.00)	0 (0.00)	2 (40.00)	2 (40.00)	4.00	1.23		

items	career title*	frequency (N) and the answers percentages [%]					$\bar{X}$	SD	χ^2	p
		1	2	3	4	5				
I am satisfied with the protective equipment needed in the school to carry out practical work.	A	0 (0.00)	2 (18.20)	2 (18.20)	2 (18.20)	5 (45.50)	3.91	1.22	8.03	0.09
	B	0 (0.00)	5 (31.30)	7 (43.80)	3 (18.80)	1 (6.30)	3.00	0.89		
	C	2 (4.30)	8 (17.00)	10 (21.30)	16 (34.00)	11 (23.40)	3.55	1.16		
	D	0 (0.00)	3 (15.80)	4 (21.10)	7 (36.80)	5 (26.30)	3.74	1.05		
	E	0 (0.00)	3 (60.00)	0 (0.00)	2 (40.00)	0 (0.00)	2.80	1.10		
The organized training (working groups. seminars, etc.) helps me to carry out my practical work competently.	A	1 (9.10)	0 (0.00)	3 (27.30)	3 (27.30)	4 (36.40)	3.82	1.25	6.82	0.15
	B	2 (12.50)	3 (18.80)	6 (37.50)	3 (18.80)	2 (12.50)	3.00	1.21		
	C	1 (2.10)	3 (6.40)	10 (21.30)	25 (53.20)	8 (17.00)	3.74	0.97		
	D	0 (0.00)	2 (10.50)	5 (26.30)	9 (47.40)	3 (15.80)	3.68	0.89		
	E	0 (0.00)	1 (20.00)	0 (0.00)	4 (80.00)	0 (0.00)	3.60	0.89		
Slovenian manuals for teachers are insufficiently supported by laboratory and experimental content.	A	0 (0.00)	3 (27.30)	3 (27.30)	3 (27.30)	2 (18.20)	3.36	1.12	6.07	0.19
	B	0 (0.00)	3 (18.80)	4 (25.00)	4 (25.00)	5 (31.30)	3.69	1.14		
	C	5 (10.60)	13 (27.70)	13 (27.70)	11 (23.40)	5 (10.60)	2.96	1.18		
	D	4 (21.10)	2 (10.50)	7 (36.80)	4 (21.10)	2 (10.50)	2.89	1.29		
	E	0 (0.00)	0 (0.00)	2 (40.00)	3 (60.00)	0 (0.00)	3.60	0.55		
A lesson with practical work as the leading teaching method takes too much time.	A	2 (18.20)	3 (27.30)	2 (18.20)	1 (9.10)	3 (27.30)	3.00	1.55	5.70	0.22
	B	2 (12.50)	3 (18.80)	4 (25.00)	2 (12.50)	5 (31.30)	3.31	1.45		
	C	5 (10.60)	11 (23.40)	4 (8.50)	16 (34.00)	11 (23.40)	3.36	1.36		
	D	4 (21.10)	6 (31.60)	4 (21.10)	3 (15.80)	2 (10.50)	2.63	1.30		
	E	0 (0.00)	0 (0.00)	1 (20.00)	3 (60.00)	1 (20.00)	4.00	0.71		
I feel confident enough to carry out the practical work in class successfully.	A	0 (0.00)	0 (0.00)	2 (18.20)	4 (36.40)	5 (45.50)	4.27	0.79	5.60	0.23
	B	0 (0.00)	0 (0.00)	2 (12.50)	6 (37.50)	8 (50.00)	4.38	0.72		
	C	1 (2.10)	1 (2.10)	0 (0.00)	16 (34.00)	29 (61.70)	4.51	0.80		
	D	2 (10.60)	0 (0.00)	0 (0.00)	7 (36.80)	10 (52.60)	4.16	1.39		

items	career title*	frequency (N) and the answers percentages [%]					$\bar{X}$	SD	χ^2	*p*
		1	2	3	4	5				
	E	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	5 (100.00)	5.00	0.00		
The lab assistant makes it easier for me to carry out the practical work.	A	0 (0.00)	5 (45.50)	2 (18.20)	0 (0.00)	4 (36.40)	3.27	1.42	5.12	0.28
	B	3 (18.80)	1 (6.30)	2 (12.50)	5 (31.30)	5 (31.30)	3.50	1.51		
	C	13 (27.70)	5 (10.60)	9 (19.10)	9 (19.10)	11 (23.40)	2.98	1.58		
	D	1 (5.30)	1 (5.30)	5 (26.30)	5 (26.30)	7 (36.80)	3.84	1.17		
	E	1 (20.00)	0 (0.00)	1 (20.00)	0 (0.00)	3 (60.00)	3.80	1.79		
I do not feel confident enough to do the practical work remotely.	A	3 (27.30)	3 (27.30)	4 (36.40)	0 (0.00)	1 (9.10)	2.36	1.21	5.10	0.28
	B	3 (18.80)	4 (25.00)	4 (25.00)	4 (25.00)	1 (6.30)	2.75	1.24		
	C	12 (25.50)	13 (27.70)	12 (25.50)	7 (14.90)	3 (6.40)	2.49	1.21		
	D	7 (36.80)	5 (26.30)	5 (26.30)	2 (10.50)	0 (0.00)	2.11	1.05		
	E	2 (40.00)	3 (60.00)	0 (0.00)	0 (0.00)	0 (0.00)	1.60	0.55		
The syllabus is too extensive in terms of content/objectives for practical work.	A	1 (9.10)	1 (9.10)	3 (27.30)	3 (27.30)	3 (27.30)	3.55	1.29	4.92	0.30
	B	2 (12.50)	0 (0.00)	3 (18.80)	5 (31.30)	6 (37.50)	3.81	1.33		
	C	0 (0.00)	8 (17.00)	8 (17.00)	17 (36.20)	14 (29.80)	3.79	1.06		
	D	2 (10.50)	3 (15.80)	7 (36.80)	4 (21.10)	3 (15.80)	3.16	1.21		
	E	0 (0.00)	0 (0.00)	1 (20.00)	3 (60.00)	1 (20.00)	4.00	0.71		
For the future. I would like to see more training on the implementation of practical remote work.	A	1 (9.10)	0 (0.00)	1 (9.10)	4 (36.40)	5 (45.50)	4.09	1.22	4.52	0.34
	B	0 (0.00)	0 (0.00)	3 (18.80)	6 (37.50)	7 (43.80)	4.25	0.78		
	C	2 (4.20)	1 (2.10)	12 (25.50)	19 (40.40)	13 (27.70)	3.83	1.07		
	D	1 (5.30)	0 (0.00)	6 (31.60)	9 (47.40)	3 (15.80)	3.68	0.95		
	E	0 (0.00)	0 (0.00)	1 (20.00)	3 (60.00)	1 (20.00)	4.00	0.71		
I am satisfied with the set of materials for practical work at school.	A	1 (9.10)	1 (9.10)	4 (36.40)	2 (18.20)	3 (27.30)	3.36	1.50	4.24	0.37
	B	1 (6.30)	1 (6.30)	7 (43.80)	6 (37.50)	1 (6.30)	3.31	0.95		
	C	3 (6.40)	4 (8.50)	7 (14.90)	21 (44.70)	12 (25.50)	3.74	1.13		
	D	0 (0.00)	3 (15.80)	3 (15.80)	8 (42.10)	5 (26.30)	3.79	1.03		
	E	1 (20.00)	0 (0.00)	1 (20.00)	3 (60.00)	0 (0.00)	3.20	1.30		
The curriculum for Chemistry 8th and 9th	A	2 (18.20)	2 (18.20)	3 (27.30)	2 (18.20)	2 (18.20)	2.91	1.58	4.22	0.38
	B	3 (18.80)	0 (0.00)	2 (12.50)	3 (18.80)	8 (50.00)	3.81	1.56		

items	career title*	frequency (N) and the answers percentages [%]					$\bar{X}$	SD	χ^2	p
		1	2	3	4	5				
grades should be updated.	C	1 (2.10)	7 (14.90)	15 (31.90)	12 (25.50)	12 (25.50)	3.57	1.10		
	D	1 (5.30)	1 (5.30)	8 (42.10)	4 (21.10)	5 (26.30)	3.58	1.12		
	E	0 (0.00)	0 (0.00)	1 (20.00)	3 (60.00)	1 (20.00)	4.00	0.71		
During my studies I was prepared to carry out practical work confidently in class.	A	0 (0.00)	2 (18.20)	2 (18.20)	4 (36.40)	3 (27.30)	3.73	1.10	3.24	0.52
	B	2 (12.50)	1 (6.20)	7 (43.70)	3 (18.80)	3 (18.80)	3.25	1.24		
	C	5 (10.60)	11 (23.40)	10 (21.30)	12 (25.50)	9 (19.10)	3.17	1.34		
	D	1 (5.30)	2 (10.50)	6 (31.60)	5 (26.30)	5 (26.30)	3.58	1.17		
	E	1 (20.00)	1 (20.00)	2 (40.00)	0 (0.00)	1 (20.00)	2.80	1.48		
It seems important to me that students carry out their practical work independently.	A	0 (0.00)	0 (0.00)	0 (0.00)	6 (54.50)	5 (45.50)	4.45	0.52	1.81	0.77
	B	0 (0.00)	0 (0.00)	0 (0.00)	5 (31.30)	11 (68.80)	4.69	0.48		
	C	0 (0.00)	0 (0.00)	2 (4.30)	14 (29.80)	31 (66.00)	4.62	0.57		
	D	0 (0.00)	0 (0.00)	1 (5.30)	7 (36.80)	11 (57.90)	4.53	0.61		
	E	0 (0.00)	0 (0.00)	0 (0.00)	2 (40.00)	3 (60.00)	4.60	0.55		
I think practical work in class is a waste of time.	A	8 (72.70)	2 (18.20)	1 (9.10)	0 (0.00)	0 (0.00)	1.36	0.67	1.71	0.79
	B	11 (68.80)	3 (18.80)	1 (6.30)	1 (6.30)	0 (0.00)	1.50	0.89		
	C	37 (78.70)	9 (19.10)	0 (0.00)	1 (2.10)	0 (0.00)	1.26	0.57		
	D	13 (68.40)	3 (15.80)	3 (15.80)	0 (0.00)	0 (0.00)	1.47	0.77		
	E	4 (80.00)	1 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	1.20	0.45		
A lesson with practical work as the leading teaching method takes too much time to prepare.	A	1 (9.10)	4 (36.40)	3 (27.30)	2 (18.20)	1 (9.10)	2.82	1.17	1.68	0.79
	B	2 (12.50)	4 (25.00)	7 (43.80)	1 (6.30)	2 (12.50)	2.81	1.17		
	C	10 (21.30)	10 (21.30)	9 (19.10)	12 (25.50)	6 (12.80)	2.85	1.40		
	D	6 (31.60)	5 (26.30)	3 (15.80)	3 (15.80)	2 (10.50)	2.47	1.40		
	E	1 (20.00)	1 (20.00)	3 (60.00)	0 (0.00)	0 (0.00)	2.40	0.89		
I update. add to or change at least one	A	0 (0.00)	0 (0.00)	3 (27.30)	5 (45.50)	3 (27.30)	4.00	0.76	1.12	0.89
	B	0 (0.00)	0 (0.00)	3 (18.80)	7 (43.80)	6 (37.50)	4.19	0.75		

items	career title*	frequency (N) and the answers percentages [%]					$\bar{X}$	SD	χ^2	*p*
		1	2	3	4	5				
practical exercise every few school years.	C	0 (0.00)	3 (6.40)	4 (8.50)	22 (46.80)	18 (38.30)	4.17	0.84		
	D	1 (5.30)	0 (0.00)	1 (5.30)	9 (47.40)	8 (42.10)	4.16	1.17		
	E	0 (0.00)	0 (0.00)	2 (40.00)	0 (0.00)	3 (60.00)	4.20	1.10		
Practical remote work is inefficient.	A	4 (36. 40)	2 (18.20)	2 (18.20)	2 (18.20)	1 (9.10)	2.45	1.44	1.11	0.89
	B	1 (6.30)	6 (37.50)	6 (37.50)	2 (12.50)	1 (6.30)	2.75	1.00		
	C	12 (25.50)	10 (21.30)	13 (27.70)	10 (21.30)	2 (4.30)	2.57	1.21		
	D	4 (21.10)	4 (21.10)	5 (26.30)	4 (21.10)	2 (10.50)	2.79	1.32		
	E	0 (0.00)	2 (40.00)	2 (40.00)	0 (0.00)	1 (20.00)	3.00	1.23		
In order to carry out practical work effectively. It would be good if there were more chem lessons in the 8th and 9th grades.	A	0 (0.00)	1 (9.10)	1 (9.10)	7 (63.60)	2 (18.20)	3.91	0.83	0.49	0.97
	B	1 (6.30)	0 (0.00)	5 (31.30)	2 (12.50)	8 (50.00)	4.00	1.21		
	C	2 (4.30)	7 (14.90)	5 (10.60)	14 (29.80)	19 (40.40)	3.87	1.23		
	D	1 (5.30)	2 (10.50)	3 (15.80)	6 (31.60)	7 (36.80)	3.84	1.21		
	E	0 (0.00)	0 (0.00)	3 (60.00)	0 (0.00)	2 (40.00)	3.80	1.10		

career title*: A: no title; B: mentor; C: counsellor; D: councillor; E: senior councillor

With a statistically significant difference ($\chi^2_{(1,2)} = 9.91$; $p = 0.04$), teachers without the title and the title of mentor are more likely to agree with the statement that Slovene workbooks are insufficiently supported by laboratory and experimental content than teachers with the title of counsellor, councillor and senior councillor (Table 1). For the other opinions, there are no statistically significant differences in terms of teachers' job titles.

No statistically significant differences in opinion were found in relation to teachers' seniority.

In an open question, the chemistry teachers named the areas of practical work that they would like to change. The question was answered by 72 (73.47%) respondents who wrote:

- small groups of students; less numerous departments;
- lab assistant; a good lab assistant; greater availability of lab assistants;
- classroom equipment required by law and a mandatory cabinet next to the classroom (so you do not have to carry chemicals across the hall); the ability to study in a chemistry classroom or lab; classroom equipment;
- more funds to buy chemicals; more chemicals and supplies, lab materials;
- more individual experiments by the students or conducting them in groups of two;
- more time;
- the seriousness of the students' work; the students' attitude towards practical work (some come with the already formed opinion that practical work is just fun); greater interest of the students;
- frequency of performance; more practical work; daily performance of experiments;
- standardization of minimum equipment by the ministry; more equipment;
- connection between experiment and theory;
- less learning content;
- more literature;
- less preparation and cleaning;
- nothing.

4 Discussion

In this study, we were interested in the implementation of practical work in chemistry at lower secondary school. With the help of the questionnaire, we received responses from about 21% of all Slovenian primary school chemistry teachers.

Based on the age groups of the teachers, we can see that more than 80% of the teachers are over 35 years old, and about half of them are over 51 years old. However, age is not a decisive factor for the implementation of chemistry practical, as more than 90% of the respondents stated that they carry out practical (iii). We can conclude that not much has changed in more than 15 years in terms of doing practical work, although much has been written about the importance of practical work, especially in science subjects. The latter is based on the theme of the importance of student activity during lessons to achieve higher levels of cognitive knowledge, manual skill development, independence, resourcefulness, group work and other benefits of practical work. The most common reason given by the teachers surveyed for not carrying out practical work more often is mainly lack of time and too large groups of students (ii). This suggests that it would be necessary to update the curriculum to allow for as much active learning and teaching as possible. A solution for too large groups of students could be found in organizing lessons in smaller groups of students, which would allow students and teachers to do more frequent practical work, as the teacher can only qualitatively supervise and guide a certain number of students during independent work. If splitting into smaller groups is not possible, a lab assistant or other professionally trained teacher would need to be employed to lead and supervise the second group. Although the laboratory assistant is included in the chemistry curriculum for lower secondary school as a mandatory part of the learning process (Bačnik, 2011; Vilhar, 2011), according to the results of our surveys, only 61 lower secondary school teachers (60%) employ a laboratory technician. Providing of the role of a laboratory technician to support practical work is a well-functioning practice in the secondary school system, so it would make sense to introduce it in lower secondary education as soon as possible.

The chemistry teachers surveyed in the study by Seid et al. (2022) stated that 40.3 % of teachers have too little time to carry out laboratory work in chemistry lessons. These results are consistent with our findings. Around two thirds of the teachers we surveyed stated that they would like to carry out more practical work than before.

As far as practical work is concerned, teachers would like smaller groups of students and more chemistry lessons per week so that they can do more practical work.

For many questions, we found no statistically significant differences between the opinions depending on the length of service of the teachers surveyed. There were statistically significant differences between the opinions of the teachers in relation to the job title of chemistry teacher (iii). Teachers without a title and with the title of mentor were more likely to agree with a statistically significant difference that the Slovene workbooks are not sufficiently supported by laboratory and experimental content than teachers with the title of advisor, councillors and senior councillors. It can be inferred from this that teacher with higher titles also obtain the content for practical work from other sources, while teachers with a lower title or no title would like to have more content for practical work in their workbooks, as this would make the work easier (iii). From the latter, the importance of professional experience can be deduced, from which the autonomy, independence and sovereignty of the teacher's work is derived. The researchers found that Slovenian chemistry teachers are not aware of all the skills that students can develop during experimental work. They are only aware of the content objectives, and there are deficits in the objectives related to experimental work and in the objectives related to broader scientific competences (Logar, 2016; Logar, Peklaj and Ferk Savec, 2017).

From the teachers' opinions we can conclude that the students like practical work in chemistry, that they mostly enjoy doing it and that it is interesting for them (i). However, this opinion is not shared by all students in the class, as some students do not actively participate in the work and do not take the work seriously (i). This makes the teachers' work considerably more difficult, as they disturb other students who would like to actively participate. For this reason, teachers’ pay particular attention to disciplinary aspects when setting learning objectives.

The teachers in this study believe that practical work has many advantages (i), which is why they do it extensively. Mainly because of the weaknesses, challenges and problems of practical work that we have outlined in the theoretical and empirical work. Students can only achieve a higher level of knowledge through active working methods - active learning in practical work emphasises direct experience (Puhek et al., 2011). In order for students to develop a higher level of knowledge, the teacher should involve students in formulating questions, planning research and producing work (Gmajner, 2012). Achieving a higher level of knowledge requires a fundamental shift towards methods and forms of work that require students to think actively and critically. Considering the results of this research that chemistry teachers mainly use Slovenian workbooks, the Internet and textbooks as a source for practical work and at the same time cite lack of time as a reason for the frequency of practical work, it would be necessary to create a kind of handbook/workbook that would make it easier for teachers to prepare students to actively carry out practical work. Examples of practical work in individual subjects would also be welcome as teachers feel that there are not many subjects that can be implemented practically. In order to increase the implementation of practical work, especially in the form of student activities, teachers would like to have a specialist laboratory assistant who is competent to help with the implementation of practical work and is available to them at all times (ii).

Teachers believe that society and the school system support theoretical content. They are convinced that students who learn theory (well) have priority at school, but not creative students and researchers. It would be easier for subject teachers to do practical work if students were already familiar with practical work at class level.

Limitations

The survey was conducted after the pandemic, when teachers were mainly working on computers, so they had no patience for another survey. However, the results suggest that lack of resources (e.g., lab equipment), lack of time to conduct lab work, and lack of commitment to lab activities are the main factors affecting the implementation of lab work. Perhaps now is the right time to get more time for lab work because the Slovenian curricula are being updated, so we could provide more time for students' lab work, which is crucial for chemistry practice. For future work, the use of traditional lab versus digital lab or augmented reality in the chemistry lab could be explored and which of these learning strategies has the most potential for students. Special attention should be paid to green chemistry (or sustainable chemistry is a concept in chemistry and chemical engineering that attempts to significantly reduce the consumption of hazardous substances and the resulting by-products in the development of products and processes (Mele Dužnik, 2019).) in experimental laboratory work and its implementation in Slovenian secondary and primary education.

Acknowledgments

Special thanks to the biology teacher Tamara Hajdinjak for the technical part of the achievement.

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