FOLIA 366

Annales Universitatis Paedagogicae Cracoviensis

Studia ad Didacticam Biologiae Pertinentia 12 (2022)
ISSN 2083-7267
DOI 10.24917/20837267.12.2

I. The role of school and the environment in social adaptation and assistance in mental crisis. Science and technology education and global justice

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Practical aspects of chemistry in the context of the necessity to survive

Introduction

As chemistry teachers, we are looking for new and better solutions, and preparing new, better teaching aids. We research what our students are interested in, and what they are not. We think about the accuracy of drawings in textbooks, and the possibility of using online laboratories or computer models. We check the competencies of students and teachers. But the question arises: Can knowledge of chemistry help in times of crisis … war, hunger? (Quora; Pienta, 2014).

Background

In the past, the answer to this question was simple. It was believed that in chemistry class, the student should learn about the laws and facts he encounters in everyday life and that he would be able to explain and apply them to his needs. It was believed that by learning chemistry, the student would learn a practical aspect of science that could be used in everyday life. This was because the objects in the child's environment and used in the household were primarily composed of simple chemical compounds, the formulas and properties of which were relatively easy to explain (Nodzyńska, 2007; Turkiewicz, 1948; Matysik & Rogowski, 1966; Grodecka, 1965; Цветков, 1953; Petrů, Souček & Pacholík, 1951; Trtílek, 1957; Sotorník, Vurm & Pauk, 1957; Trtílek, Krsička & Ondráček, 1963; Pauková, Hájek & Otčenášek, 1963).

In Poland, during the economic crisis (1980s) (Zawistowski, 2017), the pupils made various products on their own, in the chemical class, which were missing in the shops. For example, they produced soap (made of fat and sodium hydroxide), which corresponded to the saponification reactions in chemistry classes (Kopek-Putała & Nodzyńska, 2020; Pietrzak, Walosik, Nodzyńska & Kubis, 2015). While discussing the properties and use of salt, students received toothpaste (made of calcium and magnesium carbonate). And they got glue from starch – in the chemistry

lesson, there was a topic – the use and properties of starch. Students also made matches (from zinc oxide, sulfur, glass dust, potassium chlorate and gelatin) that correspond to the topics: oxides, non-metals, combustion reaction, an oxidation--reduction reaction. They also learned to check – with iodine solution – whether the cream bought on the market is artificially thickened with flour. In the chemistry curriculum, this is the topic: starch detection. The question arises: Are NOW the students competent enough to do this? how can we create future critical thinkers and problem-solvers that will understand the necessity of sustainability and yet still be prepared to tackle the upcoming energy and water crises of our planet? (Jaini).

These topics were and are now in the core curriculum of chemistry and in textbooks both in Poland, the Czech Republic and Slovakia (Nodzyńska & Cieśla, 2015; Jaini; Janotová & al. 2020; Aichnger & al. 2017). However, their implementation differs significantly. Formerly, the emphasis on practice, now definitions and theory (Nodzyńska, 2010).

Research shows that currently, students do not know WHY they should have this knowledge – and whether it has any practical application (Howell, Yang, Holesovsky, & Scheufele, 2021; Smetanova, 2018). They cannot use theoretical knowledge in practice (Ali, De Jager, 2020; Birkenholz, & Others, 1993; Hess & Trexler, 2011). They think they don't need it (Ali, De Jager, 2020; Dohn, & Dohn, 2017).

Several years ago, culinary activities such as pickling mushrooms and vegetables in vinegar, cabbage or cucumbers, roasting, and preparation of jams and wines were widespread. Due to the shortage of stores supplies. Food was preserved in every home (COBOS 2014). Food preservation skills relate to the practical application of many elements of natural knowledge, including chemistry. The children learned these skills by helping their parents and grandparents with the housework. Then, during schooling, the children gained theoretical knowledge about the processes they knew before. The practical skill of pickling mushrooms and vegetables and marinating meat in vinegar was supplemented in biology lessons with theoretical information: toxin-producing bacteria cannot grow in an acidic environment (eg Clostridium botulinum producing botulinum poison). The pickling of cucumbers and cabbage, popular in Poland, are examples of lactic acid fermentation discussed in chemistry lessons. Roasting meat or making bread and jam-making are examples of the Maillard reaction discussed in chemistry lessons. Homemade wine production in chemistry lessons corresponds to alcoholic fermentation. Nowadays, most people buy ready-made food products (Sen, Antara, & Sen, 2019), so students often do not have the practical knowledge they need and do not see the possibility of applying their theoretical knowledge. For example, many children believe that milk comes from a factory. This is evidenced by, inter alia, numerous courses and trainings showing children how milk is produced (Wimmers, 2021).

In chemistry lessons, students discuss lactic fermentation but they have never acidified the milk on their own. Students learn about protein shearing under the influence of temperature but they have never made cottage cheese on their own.

Also, students learn about the protein shearing with salt but they have never preserved e.g. herring with salt on their own.

Given the students' lack of practical knowledge, the question arises: Without access to the store, will students be able to preserve food on their own? Bake bread, bake the meat; make cottage cheese, jam, and wine?

However, in times of crisis, knowledge of chemistry is needed not only in the kitchen. Knowledge of chemistry allows you to supplement the missing cosmetics, protect metals against corrosion (Nodzyńska & Cieśla, 2009), and impregnate clothes or shoes. Finally, some of the most important survival skills are obtaining water and decontaminating wounds. The first aid kit also contains many chemicals (see Table 1).

Table 1. Composition of the survival first aid kit

Chemical substance	Application
hydrogen peroxide (H_2O_2)	decontamination
swabs soaked in ethyl alcohol (C_2H_5OH)	local disinfection of the edges of the wounds
potassium permanganate ($KMnO_4$)	decontamination of drinking water, preparation of an antifungal solution, disinfection of wounds
saline (NaCl)	rinsing the eyes
Burow's solution ($Al(CH_3CO_2)_3$)	compresses of bruises and swelling

All substances and their properties listed in the table are discussed in chemistry lessons, but students do not use this knowledge in practice.

One of the most important survival skills is the ability to start a fire. Here, too, chemistry can help. Glycerin mixed with potassium permanganate ignites spontaneously. (First aid kits in a servival often contain these reagents, not matches, which can get wet.)

Literature review

In Polish, Czech and Slovak chemistry textbooks, the content is discussed theoretically. They lack both references to the context of everyday life and practice (Ali & De Jager, 2020). If there are examples of practical applications, they are discussed after the theory. The textbooks do not prepare for problems that may arise during crises.

When searching for articles on this topic, Web Of Science asked the questions "chemistry" & "crisis" and the search was limited to articles on didactics. 32 articles were received. 17 articles concerned teaching chemistry in the covid era. 5 concerned the water crisis. 2 were for an energy crisis and one was for radiation. 1 concerned the LACK OF CHEMISTRY TEACHERS. Subsequent individual articles describe – an overview of the main problems facing doctoral students' education in the field of chemistry, the climate crisis, and compare the use of the concept of the system in teaching the concepts of chemical cores or interdisciplinary topics related

to chemistry. And one is completely off-topic. The only Gentiles (2019) describes the so-called Complex Systems as preparation for the coming changes and crises. So as to prepare new generations of students to face the challenges of Complex Systems.

After entering the slogans "preparing students for war" and "chemistry", we will receive texts about chemical warfare, the use of war gases or napalm.

It seems that although the knowledge of the basics of food preservation, water distillation and wound dressing is necessary from the point of view of crisis situations, it was not described/tagged in this way and it does not appear directly in the Core Curriculum or curricula. The articles describing the basic skills necessary to survive mention, among others skills such as preparation, food protection, water purification or treatment options (Aqsa Khan; Quora; Kassam, Avery, & Ruelle, 2016; Scriven, 1985). However, there is no description that these skills are related to the theoretical knowledge acquired in chemistry or biology lessons. Therefore, younger people who have different consumer experiences may not be aware of the necessity of having these skills. For example, nowadays most young people buy ready-made frozen food, not prepare it at home (Sen, Antara, & Sen, 2019).

Further research led to a title that sounded similar to "Survival Chemistry: Using Everyday Things to Create Energy and Drinking Water", but the experiments described there require the use of laboratory glassware.

The main source of theoretical knowledge in chemistry should be school and formal education (we are not talking about disconnected information from TV or the Internet). But does the same apply to the practical skills based on chemical knowledge? Research comparing the percentage of practical knowledge from school and non-formal sources was carried out by, among others: Ogunjobi, Owolabi and Adejoye, (2018) and Dziob et al. (2022). Their research shows the predominance of sources of non-formal knowledge.

Methodology of the research

Purpose of research

It was decided to test the declared knowledge of people of different ages regarding their knowledge of chemical knowledge, which will allow them to survive during the crisis. It was also decided to check the sources of this knowledge. What skills do students learn from formal education at school and from informal education (from the family home, TV, Internet)? We also wanted to see if there are differences between food preparation knowledge and other survival skills.

Description of the research tool

A questionnaire with closed questions was used as a research tool. The online survey contained 13 questions. Each question was divided into two parts. The first part concerned the declared knowledge of the respondent. The students could choose from 2 answers: No / Yes. The second part was about the source of the information.

The students could choose from 5 answers: No; Yes, at school; Yes, on TV, on the Internet; Yes, my parents and friends showed it to me; Yes, other than stated. (This part of the question is marked with an A.) The survey was created in Google Forms. The link to the survey was sent to teachers cooperating with the University. The questionnaire was sent in the same way to students of primary and middle schools. University students were also asked to fill in the questionnaire (mainly in chemistry, but also those students who have basic chemistry in their programs). The respondents were asked to send it further.

Description of the research group

127 people from the Czech Republic took part in the survey (including 72 women, 47 men and 8 people who chose the answer "other" or "I do not want to answer this question").

The group was diverse in terms of age (the youngest participants were under 15 and the oldest over 65). The most numerous group were students between 16 and 19 years of age (46.5%). Then, students up to 15 years of age (18.1%) and people aged 20–25 (16.5%). People over the age of 25 accounted for 18.1% in total (0.8% of respondents do not want to answer this question). The respondents also have different levels of chemical education. 23.6% learn chemistry in primary school, 46.5% learn chemistry in secondary school. 18.9% passed the high school diploma in 2010 or later. And 11% passed the high school diploma before 2010.

Research results

The table below presents the respondents' declarative responses.

Table 2. Percentage of answers Yes to individual questions

no.	question	% answers Yes
1	Can you start a fire with a chemical reaction?	58.3
2	Can you disinfect wounds with chemicals?	**72.4**
3	Can you purify water during survival?	67.7
4	Can you remove the limescale yourself with chemical reagents?	63.0
5	Would you be able to impregnate (e.g. leather, wood, fabric) with chemical agents?	49.6
6	Can you protect the metal against corrosion (without the use of anti-corrosion paints)?	44.1
7	Can you make soap at home?	65.4
8	Can you make yogurt yourself?	*33.1*
9	Can you make cottage cheese yourself?	40.9
10	Can you preserve mushrooms, vegetables or meat with vinegar yourself?	**74.8**
11	Can you make sauerkraut or pickled cucumbers yourself?	**70.9**
12	Can you make the jam yourself?	**70.9**
13	Can you make your own wine?	*26.8*

As we can see in the table above, the declared skills of the respondents are very different and depend on the question. More than 70% of positive responses are related to medicine (disinfecting wounds) and food preservation (pickling vegetables and meat, making sauerkraut or cucumbers and making jam). The p-value (one-sided test is 0.068147) calculated in the statistical program (https://www.naukowiec.org/program-statystyczny.html) is greater than the alpha value of 0.05, so we can assume that the differences are statistically significant. Correlations between the age and gender of the respondents are discussed below.

On the other hand, kitchen skills such as making sour milk and making wine obtained the lowest percent of responses (33.1% and 26.8%). It seems that the explanation of the diverse level of knowledge of the respondents can be found in the answers to the second part of the questions. The second part of the question was whether and where the respondents saw the use of the chemicals.

Table 3. Percentage of answers to individual questions

	1A	**2A**	**3A**	**4A**	**5A**	**6A**	**7A**	**8A**	**9A**	**10A**	**11A**	**12A**	**13A**
No	26	37	25.2	33.1	33.1	**48.8**	18.9	**55.1**	33.1	22	18.9	14.2	31.5
Yes, at school	**40.9**	12.6	3.9	10.2	7.1	13.4	22	7.1	5.5	0.8	1.6	0.8	3.9
Yes, on TV, on the Internet	18.9	14.2	**55.9**	17.3	20.5	13.4	*38.6*	12.6	*29.1*	4.7	7.9	11.8	29.9
Yes, my parents and friends showed it to me	3.9	23.6	8.7	28.3	26.8	18.1	12.6	14.2	22.8	**66.9**	**68.5**	**67.7**	26.8
Yes, other than stated	10.2	12.6	6.3	11	12.6	6.3	7.9	11	9.4	5.5	3.1	5.5	7.9

The percentage of respondents choosing the answer "I have never seen this" is very different from one question to another. The least number of respondents saw how fermented milk is produced and how metals are protected against corrosion without the use of anti-corrosion paints (55.1% & 48.8%). However, only less than 20% have never seen how sauerkraut or cucumbers are made and how jam is made.

School as a source of practical information useful in both safe and crisis times turns out to be insufficient. The only information remembered by respondents from school (by 40.9% of respondents) is how to start a fire with chemicals. (This experiment is often shown in schools as a motivating factor in learning chemistry.) The worst answers were to two questions: 10A and 12A (Have you ever seen the process of pickling mushrooms, vegetables or meat in vinegar? Have you seen how jam is made?). Only less than 1% of respondents remember this information from the school. Although acetic acid fermentation and the Maillard reaction are discussed in chemistry lessons. Less than 5% of respondents remember information from the school regarding 3 questions: 3A, 11A, 13A (Have you seen how to purify water during survival? Have you seen how sauerkraut or cucumbers are made? Have you seen how wine is made?). On average, only 10% of the information on survival was remembered by students from school.

Television and the Internet have proved to be very useful sources of informal knowledge about the practical aspects of chemistry. On average, students remembered from these sources over 21% of the information necessary for experiencing in times of a catastrophe. The most frequently remembered information (over 55.9%) was the answer to question 3A. Have you ever seen how to purify water during survival? The next four questions scored high. Almost 40% to questions 7A (Have you ever seen soap making at home?) and almost 30% to questions 9A and 13A (Have you ever seen how cottage cheese is made?, Have you ever seen how wine is made?), and more than 20% to the question 5A (Have you ever seen how it is impregnated (leather, wood, fabric) with chemical agents?). Only two questions had less than 10% of the answers: 10A and 11A (11A. Have you ever seen how sauerkraut or cucumbers are made? 12A. Have you ever seen how jam is made?).

As a percentage, the role of parents in gaining the knowledge necessary for survival seems to be the greatest (29.9% on average). However, it should be taken into account that this is due to the answers to three questions: 10A, 11A, 12A (Have you ever seen the process of pickling mushrooms, vegetables or meat in vinegar?, Have you ever seen how sauerkraut or cucumbers are made?, Have you ever seen how jam is made?). The percentage of answers to these questions is very high, ranging from 66.9% to 68.5%. These questions relate to the preservation of food at home, so it is logical that respondents most often indicate the home as the source of their knowledge. The answers to the remaining questions are much lower. Below 10% of the answers are two questions 1A and 3A (Have you ever seen a fire break a chemical reaction?, Have you ever seen how to purify water during survival?).

If we want to indicate the main source of information for each question and omit the answer "No", it turns out that the school is the main source of information for only one question (1A), TV and the Internet are the main source of information for four questions (3A, 7A, 9A, 13A). Whereas the family and friends for eight (2A, 4A, 5A, 6A, 8A, 10A, 11A, 12A).

The Pearson correlation coefficient was calculated for the questions concerning the declared chemical knowledge and gender, age and level of chemical education. As expected, there is practically no correlation between gender and the responses of the respondents. Only for questions 9 and 12 a weak correlation was found. The hypothesis that the older a given person is, the more tasks they can perform on their own has been confirmed (low or average correlation in all the questions examined). The dependence of knowledge on the level of chemical education is ambiguous. For 6 questions, it is below 0.2, which means there is practically no correlation (2, 3, 5, 6, 9, 13). For the remaining 7 questions, Pearson's correlation coefficient does not exceed 0.27. So we can talk about a weak correlation.

The Pearson correlation coefficient was also calculated for questions about the source of chemical knowledge and gender, age and level of chemical education.

For questions 2A, 8A and 9A, a very weak positive correlation regarding gender was found (which means that women indicated school as a source of information

for their knowledge slightly more often). And for question 1A, a very weak negative correlation was found (which means that men indicated school as a source of information for their knowledge slightly more often). In the remaining questions, there is no correlation between gender and the sources of knowledge indicated by the respondents.

More correlations can be found between the questions about the sources of information and the age of the respondents. In eight questions (1A, 2A, 4A, 7A, 8A, 9A, 10A, 12A) we can talk about a weak, positive correlation (i.e. the older the respondents were, the more often they indicated school as a source of information). In one question (3A) there is a weak negative correlation (this means that the younger the respondents, the more often they indicated school as a source of information).

However, the number of correlations between questions about information sources and the level of chemical education is not large. In four questions (1A, 2A, 4A, 10A), we can talk about a weak, positive correlation (i.e. the higher the level of chemical education the respondents were, the more often they indicated school as a source of information).

Discussion

Research has shown that the practical knowledge of students allowing them to survive in a crisis is not sufficient. The best (over 70% of answers) students know the answers to four questions 10, 11, 12 and 2. Five questions (5, 6, 8, 9, 13) have less than 50% of the answers. This is due to the fact that such experiments are not carried out at school (Pienta, 2014; Jaini). The subjects do not know how they could use their theoretical, chemical knowledge, which is analogous to the research described by Ali, De Jager, (2020), Birkenholz, & Others, (1993), Hess & Trexler (2011), Howell, Yang, Holesovsky, & Scheufele (2021), Smetanova (2018).

Research has also shown that the source of the students' practical knowledge is not the formal knowledge acquired at school. Similar results were reported by Ogunjobi, Owolabi, & Adejoye, (2018) and Dziob &. et al. (2022).

If we assume that the main sources of practical, chemical information are the family home or TV and the Internet, a low percentage of answers to the questions (5, 6, 8, 9, 13) seems obvious:

- (5) TV and Internet advertise complex chemical compounds for impregnation, such substances are also used at home; no one uses wax, oils, etc.; at school, when discussing the properties of waxes and oils, their use is not discussed (however, in times of crisis, war, it's good to know how to make waterproof shoes or clothes);
- (6) anti-corrosion paints are advertised on TV and on the Internet, and although schools show other methods of protection against corrosion (e.g. grease lubrication or galvanic coating, use of a cathode or anode), informal knowledge is stronger;

- (8, 9) at present, when left warm, pasteurized milk does not turn sour, so people do not have this experience (home-made yogurt is not only healthy and economical, but also more and more fashionable; also people who cannot drink milk due to allergies can often drink it in the form of yogurt – during the war, the ability to make yogurt can prove very useful);
- (13) parents (rightly) do not show their children how to get alcohol at home (that's why they don't have this knowledge as adults).

Conclusion

Considering that students' practical knowledge of the use of chemistry both in everyday life and in times of crisis does not come from formal school knowledge, we think that we need to fundamentally change our approach to teaching, times have changed and our students are different and have different everyday lives experiences. Since, according to a study by Howell, Yang, Holesovsky, and Scheufele (2021), people who were taught chemistry in a personal context such as cooking and personal health were much more involved, it is a need to relate school subject content to students' daily lives. This is one of the biggest problems faced by researchers in the field of chemical education.

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Practical aspects of chemistry in the context of the necessity to survive

Abstract

The article discusses how chemical knowledge (understood here as information, skills and attitudes) can be helpful in times of crisis, incl. war or hunger. In communist countries after World War II, the method of teaching chemistry at school was based on the student's practical skills acquired at home and at school (Nodzyńska, 2007). Then, in school, these skills were supplemented with theoretical data. This way of teaching allowed the student to combine practical skills and theoretical knowledge in the mind of the student, which allowed him to use this knowledge in practice. Nowadays, students often lack practical skills and at school, students encounter purely theoretical knowledge. This way of teaching may prove to be insufficient for students to be able to use this knowledge in practice during a crisis. thirteen practical skills were selected and the level of their knowledge the respondents were examined. The sources of the respondents' practical skills in the field of chemistry, which will enable them to survive in difficult times, were also examined and the correlation between the declared knowledge and sources of knowledge and gender, age and the level of chemical education. The obtained results show that the practical knowledge of the respondents about the use of chemistry both in everyday life and in times of crisis does not come from formal school knowledge.

Key words: formal and informal education; teaching chemistry; crisis situations

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