PRE–SERVICE TEACHERS´ EDUCATION: FIRST AID FOR CHEMICAL WASTE INTOXICATION

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Abstract

For a young person’s personal and professional growth, university education is very important. The top priority should be to provide the young person in question with quality education with the possibility of applying knowledge acquired in practice. Increasing the quality and efficiency of education is currently a priority aim at universities. An integral part of the preparation is taking care of Occupational Health and Safety (OHS) in the field of education and training. Current information on compliance with the principles of OHS in schools shows that this activity is not satisfactory in schools. It is, therefore, necessary to focus long-term attention not only on increasing theoretical knowledge in the field of OHS, but also and primarily on their applicability and usability in practice, and this is also true for the education of pre-service teachers of chemistry. The aim of education regarding OHS is to offer student-pre-service teachers necessary knowledge and information. To develop their skills and habits that are essential for working safely and in case of risk to provide layperson’s first aid.

The aim of this paper is to share information about possibilities regarding the education of pre-service chemistry teachers in the area of providing first aid in the case of intoxication by waste. Since pre-service chemistry teachers work with chemicals, it is important to focus on dangers which threaten not only their health but also the environment in which they work. This paper describes injuries which can occur while working in a chemical laboratory (risk of fire, explosion, and injury). It draws attention to the importance of injury prevention in the workplace with adherence to the principles of safe working practices. This paper shows the importance of training and education concerning OHS compliance for pre-service chemistry teachers.

Danger is a characteristic of working in a laboratory, which may harm the health of teachers, students, and pupils. Factors concerning danger include the dangers of working with a given substance, their quantity, the nature and knowledge of how the chemical behaves, principles regarding safe handling of the chemical, the level of technical security and organizational measures and the selection and use of personal protective equipment. Safety is endangered by working with chemicals. It is difficult for the young generation to properly observe OHS in particular in terms of hygiene and safety habit. For a young person’s personal and professional growth, university education is very important. The top priority should be to provide the young person in question with quality education with the possibility of applying knowledge acquired in practice. Increasing the quality and efficiency of education is currently a priority aim at universities. An integral part of the preparation is taking care of Occupational Health and Safety (OHS) in the field of education and training. Current information on compliance with the principles of OHS in schools shows that this activity is not satisfactory in schools. It is, therefore, necessary to focus long-term attention not only on increasing theoretical knowledge in the field of OHS, but also and primarily on their applicability and usability in practice, and this is also true for the education of pre-service teachers of chemistry. The aim of education regarding OHS is to offer student-pre-service teachers necessary knowledge and information. To develop their skills and habits that are essential for working safely and in case of risk to provide layperson’s first aid.

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The pursuit of a highly professional level of education and of quality knowledge means constantly studying. OHS is aimed at decreasing the rate of accident and injury, risk assessment, precautions using progressive arrangements from practice, plus education and development of awareness aimed at a comprehensive improvement of welfare, increasing of a “culture of work” and school preparation. OHS education and training are provided by laboratory operations and activities in the workplace or school. For evaluation of danger and risks of various types of chemicals contained in waste, it is necessary to understand, in which situation and where and why they are risky. That is why it is highly necessary to know the dangers and follow rules ensuring the safe working with chemicals.

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Keywords: Pre-service teacher, education, chemistry, chemical substance, waste, first aid.

1 INTRODUCTION

Occupational Health and Safety (OHS) has recently been one of the most important issues related to the social policy of the European Union member states [1], [2]. OHS is concerned with the safety and health protection (mental and physical welfare, social protection, working conditions, interpersonal relationships at the workplace, hygienic conditions, sanitation facilities of the workplace etc.) of employees (as well as students) related to work and workplace. One of the fundamental duties and responsibilities of employers (and school authorities) is providing appropriate care about their employees’ (and students’) safety and health protection while working (and studying). Therefore, an inevitable part of school education is the care about human safety and health protection. OHS principles specify the main arrangements whose objective is to reduce injuries at workplace and work-related disorders and illnesses [3]. An increased caution in relation to OHS is important especially in vocational schools whose graduates are educated there for their future practical occupations.

The objective of this paper is to inform about an e-learning course, which is a sub-outcome of the Cultural and Educational Grant Agency (KEGA) project of the Ministry of Education, Science, Research and Sport of the Slovak Republic (No. 044UKF-4/2017). The e-learning course includes educational texts on the topic of providing first aid in case of health threats. The educational texts are aimed at deepening the interest of in-service chemistry teachers in the field of laboratory waste arising from work with chemical substances and as chemical reaction by-products. Inappropriate disposal may cause serious health and material damage. Due to the fact that in-service teachers usually have only short-term or insufficient knowledge and experience with laboratory work, it is important to follow the OHS principles. The aim of the educational texts included in the individual e-learning course units is to highlight the interconnection (linkage) of knowledge related to the chemical composition of waste and the correct provision of first aid in case of intoxication. The idea to include such study materials in the e-learning course was motivated by frequent injuries occurring due to improper manipulation with chemical substances and failure to comply with the OHS principles. It is therefore in our interest to support the training of in-service chemistry teachers in providing first aid for intoxication of waste generated by experimental work on chemicals.

The paper addresses OHS issues, in particular the general principles for first aid in the handling of chemicals and mixtures with which in-service teachers come into contact at selected lessons, e.g. during Laboratory Practice in Analytical Chemistry.
2 INTERDISCIPLINARY APPROACH TO “FIRST AID FOR WASTE INTOXICATION WITH RESPECT TO THE CHEMICAL COMPOSITION OF SUBSTANCES” IN FORM FOR E-LEARNING

The issue of reducing the number of accidents affects the whole society as a social group, which includes students who are educated in vocational schools. It is important to motivate pre-service teachers to contribute actively to the reduction of injuries, as proper motivation is the basis of every learning effort [1], [5].

One of the outcomes of the three-year project KEGA No. 044UKF-4/2017 dealing with the issue of waste and waste management is the e-learning course entitled "Modernization of education and interdisciplinary approach in the category waste and waste management".

The e-learning course study materials were prepared to broaden and supplement the trainees' knowledge of chemical composition of laboratory waste by adding new knowledge and share experience related to the provision of first aid for injuries so that the pre-service chemistry teachers would be able to apply the knowledge in their future teaching practice. The study materials deal with providing first aid for waste intoxication based on its chemical composition. It is important to provide 'lay' first aid properly as it is a crucial opportunity to maintain one's health quality. E-learning based on knowledge identifies the learner's cognitive level to comprehend the curriculum better [6]. E-learning is one of the ways of implementing modern teaching tools in the learning process. E-learning courses are a new way of attracting students' interest and broadening their access to educational materials, and consequently of providing new information and knowledge related to first aid issues. Students' knowledge can be increased by continuous repetition of working procedures, subsequent warning of impending hazards and risks in case of improper manipulation with chemicals and failure to comply with OHS principles.

The use of information and communication technologies determines the important role of e-learning in the educational process and allows broadening and deepening the knowledge that a student should have and apply during laboratory work. The use of e-learning becomes widely accepted in formal and informal education [7], [8]. This demonstrates that e-learning has the potential to be used effectively also in first-aid training. The basic prerequisite for the verification of theoretical knowledge and the acquisition of practical skills in chemistry is then the laboratory work itself e.g. during Laboratory Practice in Analytical Chemistry.

3 METHODOLOGY

First aid is defined as a set of simple and effective measures that can be provided anywhere and at any time. The purpose of these measures is to provide immediate aid in case of sudden health risk. In addition, the purpose of first aid is to provide such care that the consequences for both the affected individual and society are minimised, in other words, to avoid complications and achieve speedy recovery of the affected and to maintain the quality of their health. The quality of first aid depends on the theoretical knowledge of basic procedures and practical skills. The development of the e-learning study materials aimed at providing first aid for laboratory injuries is based on preceding experimental research.

Research methods (knowledge test, questionnaire, interview) were used in the preparatory phase of the topics included in the e-learning course. During a seven-year period (2010-2016) a survey was conducted at the Department of Chemistry, Constantine the Philosopher University in Nitra which focused on the knowledge of in-service teachers in the third year of bachelor study and the first year of master study programme.

The survey objective: Identify in-service teachers' attitudes and views on first aid for injuries in a chemical laboratory.

The survey subject:

a) The study content of the course Laboratory Practice in Analytical Chemistry in chemistry teacher training programmes (in combination with teacher training for other school subjects, as usually pre-service teachers in Slovakia are usually trained in two majors).

b) The knowledge and experience of in-service teachers in relation to OHS.
c) Teacher trainees’ opinions and attitudes to the organisation, materials and equipment facilities in school practice.

The survey sub-objectives:

Many years of experience in teaching laboratory exercises, as well as the views of the teachers collaborating on the project, have led us to formulate the following sub-objectives:

a) Confirm that the quality and effectiveness of teaching laboratory practice is dependent on the material equipment of school laboratories.

b) Verify the knowledge level of students primarily oriented to work with chemical substances.

c) Confirm that the lack of appropriate literature has a negative impact on the level of achieved educational results.

d) Determine whether students have sufficient knowledge of first aid.

e) Verify in practice whether students’ theoretical training on how to provide first aid in case of a health danger is sufficient.

The survey sample consisted of 280 respondents.

Based on the interpretation of the survey results as well as the recommendations and experience of collaborating teachers, we prepared e-learning study materials focused on first aid provision in case of laboratory injuries. The e-learning course on first-aid issues provides opportunities for gradual increase of trainees' knowledge. There are several e-tools in the course, which may improve the learning process (chat, discussion forums, messaging, class surveys).

Based on the research problem, the main hypothesis (H) was formulated, followed by three sub-hypotheses (H1-H3):

H: E-learning aimed at providing first aid for injuries caused by waste chemicals affects changes in teacher trainees' attitudes towards health and environment protection.

- **H1**: Increasing the trainees’ knowledge of chemicals in waste helps broaden their general chemistry knowledge.

- **H2**: Information on waste separation contributes to environmental awareness and, thus, to health protection.

- **H3**: Knowledge related to the proper provision of 'lay' first aid increases the possibilities for maintaining health quality.

Basic first aid is a set of elementary technical measures which are usually provided without any specialised equipment.

The e-learning course designed within the KEKA project No. 044UKF-4 /2017 is located at the Constantine the Philosopher University in Nitra website on the “amos.ukf.sk” portal in the LMS Moodle environment. Units included in the course aimed at promoting education about providing first aid for waste intoxication based on its chemical composition are designed as a study material for pre-service teachers and as supplementary teaching material for in-service teachers (Fig. 1.). The e-learning course combines lectures in text form (MS Word) with presentations (Power Point), graphics, diagrams, testing and additional materials (tests, check lists, surveys). There are several ways to process and present the educational content, ranging from simple textual presentation of subject matter to interactive tutorials and complex simulations of real situations. Therefore, the last unit of the course includes a short video showing a provision of first aid. The strengths of the course contents lie in simulations of particular situations related to injuries caused by chemical laboratory experiment by-products.
4 RESULTS

Activities in the workplace, e.g., in a chemical laboratory, are always associated with certain dangers arising from the manipulation with chemical substances and mixtures. In accordance with the legislation in force in Annex No. 2 to the SR Government Ordinance No. 395/2006 Coll. on the minimum requirements for the provision and use of personal protective working equipment, the following hazard lists are given: physical hazards, chemical hazards, biological hazards and other hazards [9]. Chemical hazards arise from manipulation with chemicals and their effects: gases, vapours, aerosols, solids, liquid substances (divided into seven groups: toxic, caustic, irritant, sensitising, carcinogenic, mutagenic and teratogenic).

In examples we introduce the provision of first aid for acid burning, ingestion or inhalation of selected organic substance (Tab. 1).

Table 1. Giving first aid to victims of chemical exposure to selected organic substances.

<table>
<thead>
<tr>
<th>Benzene</th>
<th>Effect on human organism</th>
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<tbody>
<tr>
<td></td>
<td>It may cause cancer as well as inherited genetic disorders and diseases. Benzene is easily absorbed by the gastrointestinal tract, lungs as well as the skin. Being a lipophilic substance, it is primarily distributed to fat tissues. A part of benzene is excreted unchanged through lungs, while a part of benzene undergoes biotransformation, and newly formed metabolites are excreted in the urine. At a short-term acute benzene exposure (ingestion or vapour inhalation) it is the central nervous system which is affected most. Symptoms of milder intoxication include vertigo, euphoria, headaches, nausea and/or vomiting. A severe benzene exposure results in vision disorders, shallow and fast breathing, arrhythmia, paralysis, unconsciousness [10].</td>
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<td></td>
<td>• In case of benzene inhalation, take the affected individual from the exposure area, somewhere outdoor to get some fresh air.</td>
</tr>
<tr>
<td>Chemical</td>
<td>Effect on human organism</td>
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<tr>
<td>Aniline</td>
<td>Enter the human organism through respiratory system, gastrointestinal tract, as well as the skin. It behaves as a blood poison. Acute inhalation poisoning symptoms include headaches, tiredness, vertigo and breathing problems. Soon, cyanosis occurs (methemoglobin is formed). After ingestion, sometimes as many as 2-3 hours of a non-symptomatic period is followed by gruelling vomiting and rapid colic stomach aches. The heart rate is slowed down, pupils are widened. A severe poisoning is accompanied by spasmodic unconsciousness. The affected individual may die upon symptoms of paralysed respiratory and vasomotor centre [11].</td>
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<tr>
<td>Acetic acid</td>
<td>At high concentrations, it is very aggressive, and exposure to the skin causes extensive burns. Its vapours induce severe irritation of the respiratory tract mucosa, which results in breathing problems. If eyes are exposed to acetic acid, it leads to severe cornea burning, often resulting in irreversible blindness. According to Vanžura et al. (1976), an acetic acid solution is dangerous for eyes at concentrations as low as 2%. Ingestion of acetic acid may result in digestive tract perforation.</td>
</tr>
<tr>
<td>Chloroform</td>
<td>Although the skin absorption is not momentous and usually does not induce any acute intoxication, chloroform is absorbed fast by lungs and the gastrointestinal tract. Chloroform vapours inhalation negatively influences the central nervous system. Short-term inhalation symptoms include vertigo, somnolence and headaches. A chronic exposure causes kidney and liver damage (hepatotoxicity), since the liver metabolizes chloroform to phosgene. In some cases, upon a direct exposure to the skin allergic rashes occur (dermatitis) and/or skin boils.</td>
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<tr>
<td>Oxalic acid</td>
<td>Oxalic acid enters the human organism primarily through the respiratory tract. Being inhaled, it causes irritation of the respiratory tract, sometimes including nosebleed. If ingested, it induces rapid throat burn and stomach aches. At vomiting and diarrhoea, blood is often present. Overall, the intoxication symptoms include headaches, spasms and unconsciousness.</td>
</tr>
<tr>
<td>Picric acid</td>
<td>Picric acid gets inside the human organism at inhalation and swallowing. However, it also penetrates through the skin.</td>
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</table>
• Rinse the exposed eyes with water.
• Wash the exposed skin with a large amount of water.
• If picric acid has been ingested, have the affected individual drink half a litre of water and induce vomiting.

### Phenol

**Effect on human organism**

Phenol is easily absorbed through the skin, in the gastrointestinal tract as well as lungs. If a larger amount of phenol is absorbed, it can lead to severe, life-threatening acute intoxications, when the central nervous system (spasms, unconsciousness, breathing failure) is affected most. For adults, toxic doses of phenol range from 1-2 g, while 2-10 g phenol doses are lethal. At concentration exceeding 1%, phenol has local caustic effects. Severe necroses are caused by solutions whose concentrations exceed 10%; however, even smaller concentration at long-term contact may cause necroses. In case of eye exposure, there is a danger of cornea damage (15% solution causes cornea perforation).

- In case of a local exposure, decontaminate the exposed body parts. Phenol should be removed by cleansing the exposed surface with cotton pads and olive oil.
- Since phenol is bound to charcoal, it is recommended to administer medicinal charcoal in case of a peroral poisoning [10].
- Jaroš (1988) recommends to induce vomiting if phenol has been ingested, and drink milk or paraffin oil, whereas the exposed skin should be washed with soap and water stream.

### Methanol, methyl alcohol

**Effect on human organism**

Methanol usually gets in the human organism through the gastrointestinal tract. Its narcotic effects are milder than in the case of ethanol poisoning. Methyl alcohol is excreted more slowly from the organism. It oxidises into formaldehyde and formic acid. Methanol poisoning leads to severe acidosis and the optic nerve damage. In case of acute poisoning the symptoms are nausea, vomiting, stomach aches, inebriation, pupils do not react to light stimuli, vision is in disorder, often double vision occurs, breathing is fast and deep; eventually, vision loss may occur. The total lethal dose is 20 – 150 g (30 – 240 cm³ ingested perorally) [14], vision loss occurs if as little as 10 ml of methanol is ingested.

- In case of a methanol ingestion, peroral ethanol administration is recommended, as it prevents from toxic metabolites formation [14].
- Also, in case of a peroral poisoning, immediately administer medicinal charcoal, 200 cm³ of paraffin oil and induce vomiting [12].

### Ethanol, ethyl alcohol

**Effect on human organism**

Ethyl alcohol is present in alcoholic beverages, variously concentrated. If ingested, first comes the excitation phase, shown in increased activity; if ingestion continues, the poisoning reaches the narcotic or inhibitory phase [12].

- Prevent vomit inhalation, lay the individual in recovery position.
- In hospital, gastric lavage and charcoal administration should be performed.

### 5 CONCLUSION

Therefore, an important role is also played by the education of the young generation on how the first aid should be given in cases of chemical waste substances intoxication. Such an education includes not only the training of future specialists, but also the general training of future teachers, as they are bound to have a crucial influence on the education of children, teenagers and young adults. It is this age group which experiences injuries the most (e.g., burns, scalds, fractures, acid burnings). Currently, education with respect to the aforementioned issues tends to undergo substantial changes. Strategically and wisely, modern education policy emphasizes injury and risk prevention at school venues and facilities, including labs.

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