SECURITY & DEFENCE
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# A concept approach to use of the EU-SENSE system in exercises based on the Kolb's learning cycle

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## Abstract

*The aim of the article is to present a conceptual approach to the use of the EU-SENSE system in exercises based on Kolb's learning cycle. The methodology of the research conducted in 2018–2021 was based on an analysis of literature in the field of teaching adults and conducting training, chemical and ecological rescue, analysis of domestic and foreign materials and procedures in the field of chemical and ecological rescue, direct observation of the way of the State Guard Fire Service respond to CBRNe threats, taking place in the measurement test dams of the EU-SENSE system and for the analysis of the training module, which is an element of the EU-SENSE system. After completing the exercises, the participant should achieve learning outcomes in terms of knowledge, abilities and skills. The acquired knowledge and practical skills will allow firefighters and civilians to conduct effective and safe rescue operations in the field of chemical rescue during incidents involving hazardous chemicals in the future. Exercises in the field of chemical rescue with the use of the EU-SENSE system will lead to an improvement of skills within the State Fire Service and make it possible for it to cooperate and coordinate activities with entities cooperating in the field of crisis management activities.*

**Keywords:**

exercise, Kolb's learning cycle, EU-SENSE, CBRNe

**Article info**
Received: 2 September 2021
Revised: 9 February 2022
Accepted: 9 February 2022
Available online: 12 March 2022

Citation: Gikiewicz, M. and Kozioł, J. (2022) 'A concept approach to use of the EU-SENSE system in exercises based on the Kolb's learning cycle', Security and Defence Quarterly, 37(1), pp. 94–102. doi: 10.35467/sdq/144563.

## Introduction

In the face of contemporary threats to common safety, statistics of threats related to dangerous substances, educating human resources for the purposes of crisis management and civil protection is extremely important. In the literature, hazardous substances are understood as one or more substances or mixtures of substances which, due to their chemical, biological or radioactive properties can, if they are handled improperly, pose a threat to human life or health or the environment. A dangerous substance may be a raw material, a product, an intermediate, waste, and a substance created as a result of an accident (Environmental Protection Law 2001). In addition, the provision of modern solutions for training purposes has been identified in the "ENCIRCLE catalogue of technologies," which indicates a shortage of simulation tools and systems targeted at adults who do not deal with CBRNe rescue on a daily basis (ENCIRCLE, 2017; European Commission, 2014; Szklarski, Maik and Walczyk, 2020). This education should be based on the Kolb model because, as its originator claims, science is a process consisting in changing the previous experience under the influence of new experiences. It is based on the fact that the human mind is not a "blank card" and the learner has acquired knowledge, concepts and views much earlier, and the trainer's task is to relate to this potential and use it to the maximum (Zabłocki and Nowacka, 2015).

## EU-SENSE system

The European Sensor System for CBRN Applications (EU-SENSE) is a project funded by the European Union's Horizon 2020 research and innovation programme under the grant agreement No. 787031. The project corresponds to needs addressed in the ENCIRLCE catalogue, including to the gap identified in the field of information management, command control and communications, as mentioned above, and the lack of suitable equipment for use with untrained individuals (ENCIRCLE, 2017). The EU-SENSE system consists of (Cordis, 2021; Gikiewicz *et al.*, 2021):

- EU-SENSE Sensor Node – a heterogeneous node, which incorporates various sensors and is able to communicate with the headquarters;
- The network of chemical sensors – a network of EU-SENSE nodes, which was used for measurement data collection and during the final demonstration;
- Unified Data Model – a standardised description of the sensors network which facilitates communication between the system components;
- Environmental Noise Learning Tool – a software algorithm that uses machine learning to filter the environmental noise and, as a consequence, reduces false alarm rates;
- Source Location Estimation Tool – a software component responsible for calculating chemical threat source location;
- Hazard Prediction Tool – a tool based on contamination modelling that estimates the most probable future dispersion of the contaminant;
- Situational Awareness Tool – the main access point to the system that collects the data from various components and integrates them into the situational view;

- EU-SENSE training mode – the EU-SENSE system mode was created for training purposes. It uses the other components and artificial data in order to provide a realistic simulation environment.

The EU-SENSE training mode is a system tool created for training purposes. The end-user of the system trains in a previously prepared environment based on artificial data. The training mode fully corresponds to the operational version of the EU-SENSE system. The training mode gives end-users the opportunity to understand how sensors nodes work and how the nodes should be placed to obtain necessary information and then used during a hazardous chemical event (Dobrowolska-Opała *et al.*, 2019, p. 13).

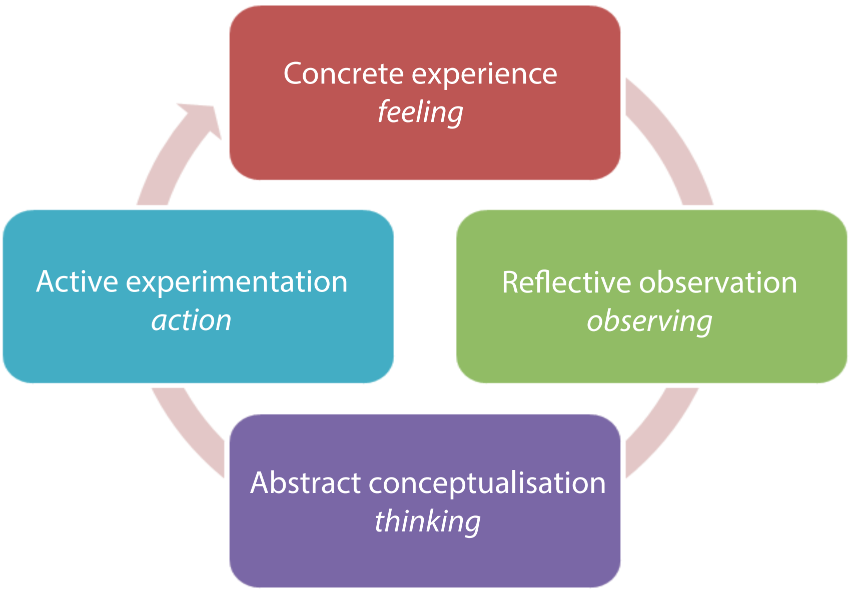
## Kolb's learning cycle

The learning process resulting from Kolb's learning cycle takes place in four stages related to four abilities and activities such as concrete experience (feeling), reflective observation (observing), theorising, creating abstract hypotheses (thinking) and active experimenting (action). This process is often called Kolb's cycle, as shown in Figure 1.

Stage I – concerns specific experiences. The participants of the exercise are given examples of situations that they may have to deal with during the implementation of activities. The facilitator analyses the observations of those participating and leads them to new experiences. The main task of the trainer is to initiate certain, specific situations and to propose tasks, after which the participants will be able to draw conclusions and convince themselves of the effectiveness of the described activities.

Stage II – reflection – is a very important stage as it allows participants to share opinions and conclusions, as well as through reflection, to visualise the mechanisms that drive behaviour. The main task of the trainer is only to moderate the discussion and start new threads, because the participants should be able to draw conclusions on their own.

**Figure 1. Kolb's cycle (Kolb and Kolb, 2013).**



Stage III – is to verify the conclusions drawn in the previous stages with the theory. This part of the cycle depends largely on the leader, although at this stage you can take advantage of the participants' activity. The lecturer sums up the group's conclusions and relates them to the theory.

Stage IV – is based on the application of new knowledge in practice under the supervision of the teacher, whose task is to introduce a correction. In this phase, it is possible to use exercises in which the participants analyse situations related to saving health and life. The essence of this stage is for the learners to consciously change their behaviour and experiment on the usefulness of theory in problem solving and decision making (Kolb and Kolb, 2013; Milton, 2010; Williamson, 2017; Zabłocki and Nowacka, 2015).

In order to maximise the effectiveness of the education process, it is necessary to choose the right teaching methods so that they take the right form. The choice of methods depends primarily on:

- learning objectives;
- group size;
- time;
- available help;
- skills and competences of the teacher;
- participants' preferences;
- the current level of attention and involvement of participants.

The choice of methods determines not only the form, but also the effectiveness of the entire education process. Education, according to Kolb's cycle, can be conducted with the use of many modern teaching methods.

## Taxonomy of learning domains and KSA model

Taking into account the aforementioned dependencies of the selection of methods, the objectives of education can be considered the basic determinant. When establishing them, the Taxonomy of Learning Domains (the so-called Bloom's taxonomy) and its further modifications, expressing three spheres of science, respectively: cognitive, affective and psychomotor, becomes extremely useful. Through these spheres, the following areas are identified: knowledge, abilities and skills that the participant should achieve – the so-called KSA Model (Adams, 2015; Badea, 2015; Hoque, 2016; Jankowski, 2013). For each area, activities expressed in the form of verbs are matched, which are responsible for the observable behaviour of people participating in the training. For the cognitive sphere, these verbs should express: knowledge, understanding, use, analysis, synthesis, evaluation, or creation (Felder and Brent, 2004; Hoque, 2016). For the specific sphere, they should correspond to the domains: receiving, responding, valuing, organisation, and characterisation. For the psychomotor sphere: perception, set, guided response, mechanism, complex overt response, adaptation, and origination (Hoque, 2016). A list of selected actions in relation to the specified learning effect is shown in Table 1.

**Table 1. List of actions regarding to specified learning effects (based on Jankowski, 2013).**

| Learning effect | Types of actions | Action |
|---|---|---|
| Knowledge | Remembering | to list, to recognise, to repeat, to match, to state, to define |
| | Understanding | to characterise, to assort, to discuss, to identify, to classify, to report, to explain, to express |
| | Applying | to interpret, to make use of, to operate, to show, to predict, to prepare, to construct, to practice, to use, to implement, to apply |
| | Analysing | to analyse, to debate, to relate, to test, to attribute, to solve, to infer, to experiment, to contrast |
| | Evaluating | to determine, to conclude, to criticise, to estimate , to rate, to check, to justify, to cogitate |
| | Creating | to formulate, to combine, to plan, to design, to elaborate, to propose, to collect, to manage, to organise |
| Abilities | Receiving | to accept, to select, to ask, to follow, to point to |
| | Responding | to read, to practice, to discuss, to answer to respond to |
| | Valuing | to participate, to demonstrate, to share, to support, to select, to propose |
| | Organisation | to discuss, to identify, to relate, to organize. to compare, to prepare, to order, to develop, to explain |
| | Characterisation | to qualify, to undertake, to act, to require, to perform, to resolve, to revise, to influence, to propose, to modify |
| Skills | Perception | to select, to adjust, to relate, to describe, to identify, to estimate, to detect |
| | Set | to be ready, to respond, to show, to state, to proceed, to react, to explain, to begin |
| | Guided response | to perform, to mix, to follow, to respond, to reproduce, to react, to trace |
| | Mechanism | to build, to demonstrate, to manipulate, to measure, to display, to organise, to use |
| | Complex overt response | |
| | Adaptation | to adapt, to revise, to modify, to use, to rearrange, to respond, to perform, to change |
| | Origination | to arrange, to build, to initiate, to compose, to combine, to design, to make, to develop, to create, to originate |

## Methods

The research is aimed at developing the concept of organising exercises with the use of the EU-SENSE system. The work was carried out in 2018–2021 at the Main School of the Fire Service and is part of the EU-SENSE project. The methodology of the research consisted of:

1. analysis of the literature in the field of teaching adults and conducting training, and in the field of chemical rescue;

2. analysis of materials and operating procedures in the field of chemical rescue available in the literature on the subject (domestic and foreign);

3. critical analysis of the currently functioning procedures of the National Fire and Rescue System (KSRG);

4. direct observation of how the State Fire Service manner responds to CBRNe threats taking place, as part of the EU-SENSE system measurement session, at the Training and Rescue Innovation Base of the Main School of Fire Service in Nowy Dwór Mazowiecki (August 2020, June 2021);

5. analysis of the training mode, which is an element of the EU-SENSE system.

On the basis of the conducted research, a concept for using the EU-SENSE system for exercises in the field of preparation and responding to chemical hazards was developed.

## Results and Discussion

The aim of the exercises is to prepare firefighters and civilians who lack specialist knowledge about CBRNe threats and the systems dedicated to them to effectively and safely conduct rescue operations in the field of chemical rescue using the EU-SENSE system.

- After completing the exercises, a participant should achieve learning outcomes in terms of knowledge, abilities and skills.

- The distribution of learning outcomes in the cognitive, affective and psychomotor spheres, taking into account the individual stages of Kolb's cycle, is shown in Table 2.

In the future, the acquired knowledge and practical skills will allow firefighters and civilians to conduct effective and safe rescue operations in the field of chemical rescue during incidents involving hazardous chemicals. The tutors should adapt the teaching methods to the specified actions mentioned, depending on the participants (their age, advancement,

**Table 2. Learning effects according to Kolb's learning cycle (based on Gikiewicz *et al.*, 2021; Jankowski, 2013).**

| Topics | Learning effects | Types of actions | Specified actions |
|---|---|---|---|
| Experience | | | |
| 1. Chemical hazards (e.g. CWAs, TIC)<br>2. Historical events related to CBRNe hazards (especially chemical releases)<br>3. Crisis management in the event of hazardous chemical release | Cognitive | Remembering | To list chemical hazards and its types.<br>To recognise the possible consequences of chemical releases.<br>To define crisis management stages. |
| | Affective | Receiving | To follow crisis management procedures in of the event of hazardous chemical release.<br>To show the required activities for each engaged entity in the frames of crisis management. |
| | | Responding | To interpret the characteristics of the chemicals.<br>To discuss the possible consequences of chemical release based on characteristics.<br>To respond to required activities in crisis management. |
| | Psychomotor | Perception | To select the crisis management stage adequate for the discussed case.<br>To describe the steps required for each crisis management stage in the event of chemical release,<br>To identify the needs of crisis management units in the event of chemical release.<br>To estimate the needs of different entities. |
| Observation | | | |
| 1. Organisation, rules for conducting chemical and ecological rescue operations in the KSRG | Cognitive | Understanding | To characterise the detection types.<br>To classify the consequences of hazardous chemical release to acute exposure levels.<br>To explain the organisation and rules for conducting chemical rescue operations. |

(*continues*)

**Table 2. Continued**

| Topics | Learning effects | Types of actions | Specified actions |
|---|---|---|---|
| 2. Acute exposure guideline levels (AEGLs)<br>3. Types of detection | Affective | Valuing | To identify the steps taken during chemical rescue operations.<br>To select the appropriate procedure for conducting rescue operations. |
| | Psychomotor | Set | To react to the organisational rules for conducting chemical rescue operations.<br>To explain different types of detection and their uses. |
| Conceptualisation | | | |
| 1. EU-SENSE System<br>2. Source Location Estimation Tool<br>3. Hazard Prediction Tool<br>4. Situational Awareness Tool | Cognitive | Applying | To make use of the EU-SENSE system in order to simulate a hazardous chemical release situation.<br>To operate the Situational Awareness Tool.<br>To use simulation results in the rescue procedure.<br>To implement simulation results into the rescue operations. |
| | | Analysing | To test new scenarios under different situational conditions.<br>To contrast simulation results with rescue organisation procedures and requirements. |
| | Affective | Organization | To discuss different EU-SENSE system simulations and results.<br>To explain usage of the EU-SENSE system in realistic situations.<br>To compare rescue operation conditions with and without the EU-SENSE system. |
| | Psychomotor | Guided response | To react to EU-SENSE system warnings.<br>To follow the rescue procedures based on EU-SENSE system recognition. |
| Experimentation | | | |
| 1. EU-SENSE Training Mode (simulation sub-mode)<br>2. EU-SENSE Training Mode (historical sub-mode) | Cognitive | Evaluating | To conclude the training mode simulation results.<br>To determine the rescue operations based on simulation results.<br>To estimate the areas under each AEGL. |
| | | Creating | To plan a new scenario for hazardous release simulation.<br>To elaborate new simulation conditions for different scenarios.<br>To propose use of the results to organise rescue operations. |
| | Affective | Characterisation | To revise historical events.<br>To propose activities in the event of hazardous release.<br>To modify simulation conditions or rescue activities. |
| | Psychomotor | Mechanism | To build a new scenario in the training mode.<br>To use the simulation results for selecting adequate rescue procedures in the analysed scenario. |
| | | Complex overt response | To manipulate the scenario independently.<br>To use the historical simulation results to independently evaluate the simulation prepared. |

(*continues*)

**Table 2. Continued**

| Topics | Learning effects | Types of actions | Specified actions |
|---|---|---|---|
| | | Adaptation | To modify the simulation input and scenario.<br>To adapt procedures and rescue operations based on simulation results. |
| | | Origination | To compose an adequate organisation procedure for rescue purposes.<br>To build a new scenario for simulation purposes. |

time availability). Moreover, the tools used during the training should enable the participants to independently operate the EU-SENSE system.

## Conclusions

Summing up, the Kolb learning styles are based on two dimensions: Concrete Experience-Abstract Conceptualization and Reflective Observation-Active Experimentation. Kolb's theory has been useful for teaching teamwork skills, for conceptualizing the design process, and for planning classes on specific topics.

Conducting exercises is one of the methods of prevention and preparation of crisis management participants to carry out tasks when there is a real threat. Thus, it can be concluded that exercises are one of the most important elements of good practices in crisis management and directly or indirectly affect the effectiveness of future activities in emergency situations. Exercises in the field of chemical rescue with use of the EU-SENSE system will not only improve skills within the State Fire Service, but also make it possible to cooperate and coordinate activities to protect human life and health, the environment, and properties with multiple entities. The experience gained after carrying out the preliminary exercises will allow weaknesses to be identified, adjustments developed, and changes to be implemented in future exercises.

**Funding**

The research is part of the EU-SENSE project founded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 787031.

**Author Contributions**

Conceptualization, M.G.; methodology, M.G., J.K.; formal analysis, M.G., J.K.; project administration, M.G., J.K. All authors read and agreed to the published version of the manuscript.

**Data Availability Statement**

Not applicable.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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