

## CHEMICAL ESCAPE ROOM AS EDUCATIONAL TOOL

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### ABSTRACT

Escape room can be an excellent educational tool for the establishment of teamwork, peer learning and communication competences within a school environment. It also provides an opportunity for making connections between real life concepts and the knowledge acquired in the traditional school system. An escape room including lab activities related to the acid-base concepts and identification of presence of natural products in common foodstuffs has been designed for the high school students aged 17-18, selected on the base of their high trimester grades in chemistry. The students were assigned to 4 working groups. The activities were conducted at the chemical laboratories of the Faculty of Science in Kragujevac. To examine students' reflections regarding their experience in escape room, an evaluation questionnaire was developed. The obtained results have indicated that implementation of the escape room in the learning of chemical concepts is increasing students' motivation, feeling of self-efficacy, teamwork competencies, as well as better understanding of the application of chemistry knowledge in everyday life.

**Keywords:** Escape room, chemistry, lab activities.

### INTRODUCTION

During last years, many educational games were developed in order to introduce students into interactive and entertaining activities (Zainuddin, Chu, Shujahat, & Perera, 2020; Rodríguez, Puig, Tellols, & Samsó, 2020). The escape room is one of the famous types of games whose implementation is relatively new in the education field (Nicholson, 2015). The basic idea behind escape room is a game in which people locked into a room try to find a way to escape by solving problems and finding clues (Nicholson, 2015). Although firstly designed as a game, escape room today represents an excellent educational tool for the establishment of teamwork, peer learning and communication competences within school environment (Taraldsen, Haara, Lysne, Jensen, & Jenssen, 2022; Pan, Lo, & Neustaedter, 2017; Warmelink et al., 2017; Wiemker, Elumir, & Clare, 2015; Wu, Wagenschutz, & Hein, 2018; Williams, 2018; McFadden, & Porter, 2018).

Chemistry is a natural science discipline that addresses different topics, starting from properties and behavior of matter, atoms and molecules, chemical bonds to the application of chemical principles in everyday life. Bearing in mind that chemistry as a subject is abounding with abstract concepts difficult for the understanding and learning, the teaching should consist of active methodologies that involve students in critical thinking skills, such as observation, analysis, inference, communication and problem-solving. The escape room could be beneficial for the learning of chemistry due to the replacement of the traditional laboratory experiments and engagement of the students in more active and problem-based activities (Peleg, Yayon, Katchevich, Moria-Shipony, & Blonder, 2019; Vergne, Simmons, & Bowen, 2019). It also provides opportunities for making connections between real life concepts and the knowledge acquired in the school system, as well as involvement of the students in active learning processes.

Although the escape room is becoming a recognizable tool in the educational system, there is not enough literature addressing the students' perception regarding the use of the escape room as an educational tool for learning chemistry. An insight into this topic could be of key importance for

understanding the influence of the escape room on the learning of chemical concepts, especially considering that students find chemistry difficult to learn. Therefore, the aims of this study were to address the influence of the implementation of the chemical escape room as a tool for learning chemical concepts on the students' perceptions about:

- their motivation
- feeling of self-efficacy and achieved team-work competencies and
- acquisition of chemical knowledge and its application in real life.

## **MATERIALS AND METHODS**

### **General background**

The research was conducted during the May of the year 2022. The study included 12 students aged 17-18 from four high schools from the Kragujevac city (Serbia).

### **Sampling**

The students were selected by purposive sampling by their teachers on the base of their high trimester grades and achievements in chemistry. The students were assigned to four working groups.

### **Instrument and procedures**

An escape room including lab activities related to the acid-base concepts and identification of presence of natural products in common foodstuffs has been designed. Prior to the realization of activities, the students were equipped with necessary knowledge about chemical equipment and operations, as well as about safe work in chemical laboratories. The activities were conducted at the chemical laboratories of the Faculty of Science in Kragujevac, and they were designed as a competition between four groups. Once the students entered the laboratory, the laboratory was locked, and the key was placed in the box closed by the padlock with 3 number-code. One teacher or assistant was present in the laboratory as moderator for safety reasons or for giving previously determined hints to the students. Multiple clues in the form of colored and labeled stickers were scattered through the laboratory drawers and closets and their deciphering has led to the next challenge. The problems that students needed to solve required chemistry knowledge and laboratory skills about determination of reducing sugar presence in common drinks (Coca Cola zero or ordinary Coca Cola), the quantity of reducing sugars in sample (Benedict reaction), the presence of vitamin C in common beverages, the detection of presence of alcohols in sample (dichromate reaction), proteins in food, as well as about the performing acid-base titration in order to find unknown mass of the NaOH in given sample. The solution of the last problem was directing students to the three-number code necessary for the releasing the hostage's lock.

To examine student's reflections regarding their experience in the escape room, an evaluation questionnaire was developed and administered to the students after the escape room activity was completed (Figure 1). The questionnaire consists of the twelve closed questions with responses based on the Likert scale – 5 (strongly agree); 4 (agree); 3 (somewhat agree); 2 disagree) and 1 (strongly disagree) (Likert, 1932). As it can be seen in Figure 1, the questions were organized and divided in three groups to address the following topics: usefulness and students' motivation; communication, self-engagement, and cooperation, as well as content and learning. For the analysis of answers, the descriptive statistics was used, and results were given in percentages.

<b>Usefulness</b> and <b>Motivation</b>	<b>Q1</b> The activities within Escape room were interesting and they have increased my motivation and interest to study chemistry contexts.
	<b>Q2</b> I felt comfortable and satisfied during solving the individual tasks within Escape room.
	<b>Q3</b> The Escape room represents appropriate activity for the learning chemical contents in easier way.
	<b>Q4</b> I recommend Escape room as an additional activity to the regular school classes.
<b>Communication</b> <b>Self-Engagement</b> and <b>Cooperation</b>	<b>Q5</b> I had opportunity to take initiative in solving the assigned tasks and problems.
	<b>Q6</b> My engagement in Escape room was greater than within regular chemistry school classes.
	<b>Q7</b> The activities within Escape room were beneficial for the establishment of the participants' communication.
<b>Content</b> and <b>Learning</b>	<b>Q8</b> The close cooperation between participants was of key importance for solving Escape room tasks.
	<b>Q9</b> I prefer solving the tasks in a group of students rather than independently within regular school classes.
	<b>Q10</b> The activities within Escape room helped me to better understand the contents from the Chemistry as a subject.
	<b>Q11</b> The conducted activities helped me to better link existing knowledge with its application in real life.
	<b>Q12</b> The knowledge and experience gained through Escape room is useful not only in school environment, but also in everyday life.

Figure 1. Questionnaire used in this study for the examination of students' reflections regarding the use of Escape room as educational tool for the chemistry learning.

## RESULTS AND DISCUSSION

The implementation of the game-based learning approach in chemistry teaching has a positive influence on the enhancement of the students' motivation (Byusa, Kampire, & Mwesigye, 2022). According to that, the first two statements in the questionnaire were used to examine to what extent students think that realized activities within the Escape room increased their motivation and interest to study chemistry contexts. In general, both statements showed the highest level of agreement, reflected in 100% "strongly agree" answers (Figure 2).

Most of the students (86%) completely agreed that the Escape room they attended represents an appropriate activity for learning chemistry and recommended it as an additional activity to the regular school classes.

The second panel of statements (5-9) was designed to address the question of the students' perceptions about the communication, self-engagement and cooperation established during the activities within Escape room. According to Johnson and Mayer (Johnson, & Mayer, 2010), an effective educational game should be created from the appropriate challenges that influence students' feeling of self-efficacy. The answers on questions 5 and 6 (related to the students' perceptions regarding their self-efficacy) have revealed that a substantial majority of the students considered their engagement within Escape room beneficial for the enhancement of initiative and self-engagement. Still, 14% of the students thought that their engagement was not greater when compared to the regular chemistry school classes. A prominent level of the agreement (86% strongly agree and 14% agree) was noticed in the answers on the questions 7 and 8 related to the students' perception about communication and cooperation established during the activities within Escape room. The same trend was observed in the answers on the 9<sup>th</sup> question, where students mostly declared that they prefer work in a team rather than individual work within school classes. It is important to emphasize that students didn't know each other before the realization of the activities, so the establishment of the cooperation and communication among them was of key importance for the accomplishment of the given tasks. This is also in agreement with some studies suggesting that collaborative learning and use of games in education could promote teamwork skills (García, López, Molina, Casas, & Ruiz Morales, 2016; Karakas Manisaligil, & Sarigollu, 2015).

Fewer percentage of the students strongly agreed that realized activities have helped them to better understand chemical contexts, as well as to link existing chemical knowledge with its application in the real life. For the interpretation of observed results, it should be taken in account

that activities in the framework of this Escape room were designed for the average-ability students (within the chemistry curriculum), while the participants were student with excellent marks and achievements in chemistry. Although the subject content is beneficial for all students, for those with high achievements and knowledge base is even critical and it requires activities that accelerate the learning beyond classical curriculum content areas.

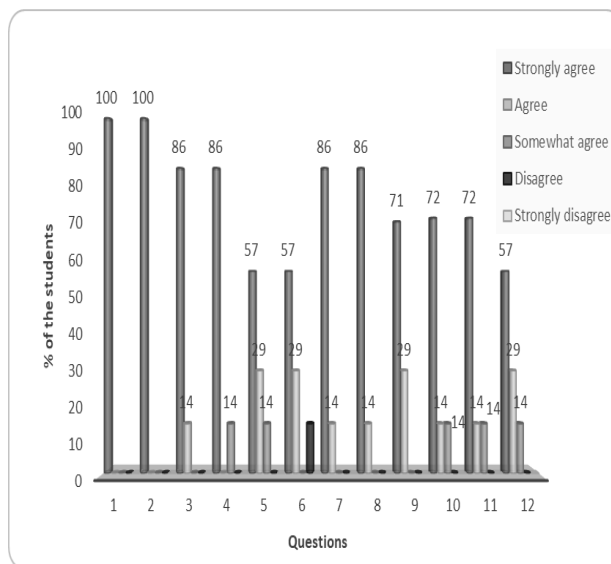


Figure 2. Survey questionnaire results.

## CONCLUSIONS

The learning of the chemistry contents is requiring the implementation of active methodologies that involve students in critical thinking and problem-solving skills. The use of practical laboratory work in chemistry is of key importance, since it is influencing practical skills in students, developing their scientific attitudes, increasing the understanding the chemical contents, etc. Still, the traditional classroom and laboratory settings are requiring significant transformations under the modern education systems conditions. One of the possible solutions could be the introduction of the chemical escape room, since it is offering the possibility for the reinforcement of the learning concepts in enjoyable, effective, and motivating way. Herein, we presented the results of the investigation of students' reflections regarding their experience in escape room designed to address the subject topics such as acid-base concepts and identification of presence of natural products in common foodstuffs. Based on students' responses from the questionnaire administered after the realization of the activity, it can be concluded that implementation of the escape room in the learning of chemical concepts is increasing students' motivation, feeling of self-efficacy, teamwork competencies, as well as better understanding of the application of chemistry knowledge in everyday life. Perhaps the most important aspect of the activity was the building of the teamwork competences, since the participants didn't know each other before the realization of the activity, but the establishment of close cooperation and communication between them was of substantial importance for the finalizing of given task and problems.

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