World Academy of Science, Engineering and Technology
International Journal of Educational and Pedagogical Sciences
Vol:16, No:9, 2022

The Practice of Teaching Chemistry by the Application of Online Tests

Nikolina Ribarić

Open Science Index, Educational and Pedagogical Sciences Vol:16, No:9, 2022 publications.waset.org/10012688.pdf

Abstract**—**E-learning is most commonly defined as a set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms and digital collaboration, that enable access to instructional content through a variety of electronic media. The main goal of an e-learning system is learning, and the way to evaluate the impact of an e-learning system is by examining whether students learn effectively with the help of that system. Testmoz is a program for online preparation of knowledge evaluation assignments. The program provides teachers with computer support during the design of assignments and evaluating them. Students can review and solve assignments and also check the correctness of their solutions. Research into the increase of motivation by the practice of providing teaching content by applying online tests prepared in the Testmoz program, was carried out with students of the 8th grade of Ljubo Babić Primary School in Jastrebarsko. The students took the tests in their free time, from home, for an unlimited number of times. SPSS was used to process the data obtained by the research instruments. The results of the research showed that students preferred to practice teaching content, and achieved better educational results in chemistry, when they had access to online tests for repetition and practicing in relation to subject content which was checked after repetition and practicing in "the classical way" – i.e., solving assignments in a workbook or writing assignments in worksheets.

Keywords**—**Chemistry class, e-learning, online test, Testmoz.

I. Introduction

THIS paper presents an example of the application of digital materials, online tests, in teaching and examines whether the implementation of the use of information and communication technologies (ICT) in teaching has positive effects on students' motivation. It provides a brief overview of the teaching content that students learn in the eighth grade of primary school, and the recommendations of the European Parliament and Council, 2006, on the key elements of science competence.

The concept of e-learning is described and defined, and various forms of e-learning are described. The goal of the research and the methodology used are explained below, and the conclusions that have been drawn are discussed.

A. E-learning

E-learning is a cross-section of the world of education and the world of ICT [1]. Compared to traditional teaching, which focuses on the teacher and his control over the classroom, subject matter content and the learning and teaching process, e-learning puts the student at the center, enabling interactive learning at his own pace, in a simple, flexible distributed learning environment [2], [3].

Today, e-learning is most commonly defined as a set of applications and processes, such as Web-based learning, computer-based learning, and virtual classrooms and digital collaboration, which provide access to subject matter content through various electronic media (CD-ROM, Internet, intranet, extranet, audio and video, satellite, etc.) [4]. The current approach to e-learning is related to the emergence of WEB 2.0 (Social Web) and 3D technology, where the focus of media-didactic interest is the design of digital learning environments in which informal learning will be in function of achieving improved learning success [5].

When speaking about online learning, different terminology is often used, so it is difficult to single out one generic definition. Commonly used terms are e-learning, Internet learning, distributed learning, networked learning, tele learning, virtual learning, computer-assisted learning, Internet-assisted learning, and distance learning. All of these terms imply that the student is away from the teacher; the student uses some form of technology (usually a computer) to access teaching materials; the student uses technology to communicate with the teacher and other students; and students are provided with some form of support. The term e-learning and online test will be used in this text.

Ally [6] states that e-learning enables access to educational information from any place and, more often, at any time. It enables participants in teaching to overcome time and space limitations [7]. However, the materials must be designed so that they engage the students and they should support learning. The methods for the execution of online teaching enable flexible access, from any place, and, more often than not, also at any time, but learning and teaching must be based on adequate principles of teaching design. According to Rossett, e-learning has a lot of potential, but it requires commitment and funds, and it must be designed in the right way [8]. To design it in the right way means that the materials must be well designed, oriented towards the students and learning, and adequate support must be ensured. Ring and Mathieux believe that online learning must be strongly rooted in practice, i.e., the students should learn in the context of the workplace, which must be characterized by a high level of interaction and cooperation [9].

Although digital technologies and the Internet have caused great changes over the past 10 years or so, and in the context of education, the application of e-learning is limited, despite the efforts and promotion carried out. One of the obstacles in most Croatian schools is certainly the poor IT infrastructure. Despite

Nikolina Ribarić is with Društvo Naša Djeca Jastrebarsko, Croatia (e-mail: dndjastrebarsko@gmail.com).

Open Science Index, Educational and Pedagogical Sciences Vol:16, No:9, 2022 publications.waset.org/10012688.pdf

the numerous activities carried out by institutions whose basic task is to teach about e-learning technology, teachers are insufficiently informed about the benefits of applying e-learning in teaching.

Numerous applications are available to teachers. Testmoz [10] is a simple application for creating online tests. It enables the teacher to easily prepare a test, with numerous options for designing the appearance of the test, it provides information on the answers and test results. The teacher plays the role of administrator: he/she assigns a name to the test, chooses a password with which students will access the test; assigns a web address in the format testmoz.com/123456 and designs the assignments. When designing a test, four types of questions can be combined: multiple-choice questions with one correct answer, true/false questions, multiple-choice questions with multiple correct answers, and open-ended questions. The order of the created questions can be edited according to needs, and each answer can be assigned an appropriate number of points. Upon completion of the test design, the teacher publishes the test, i.e., the test becomes available online to users (students). Each student has an access password that they must enter to access the test. Upon completion of the test, reports on the test results achieved are generated. Students and the teacher receive feedback/a list of correct answers, i.e., the number of points achieved.

B. Natural Science Literacy and the Subject of Chemistry

The term natural science literacy refers to the ability to use natural science knowledge, identify questions and draw conclusions based on evidence in order to understand and facilitate decisions about the natural world and the changes caused by human activity. According to the 2006 recommendation of the European Parliament and Council [20], key natural science competence implies a combination of basic knowledge of the principles and structure of nature, key skills and the ability to use data to draw conclusions, and development of positive values and attitudes.

The educational strategy applied in the teaching of chemistry corresponds to the strategy of scientific research: it starts from problems and makes assumptions. Students conduct experiments, record observations and measurements, and draw conclusions. Student mini-projects are particularly important in the teaching of chemistry, and encourage creativity, logical reasoning and connecting knowledge from diverse scientific fields.

Through the subject of chemistry in the eighth grade of primary school, students are taught about non-metals, metals, salts, mass fractions of elements in a compound and compound formulae, carbon and its compounds, fossil fuels, hydrocarbons, alcohols, carboxylic acids, esters, fats and oils, sugars, amino acids and proteins, enzymes, soaps and detergents and plastics.

Evaluation includes all activities that provide information on how and to what extent the goals of educational activities are achieved [11]. Testing is the very procedure which is aimed at determining the level of knowledge acquisition, on the part of the subject being tested. Bognar and Matijević state that the educational process starts from the need to achieve specific goals, so an evaluation, i.e., appraisal of the validity of such an achievement, is expected too [12].

II. Aim of the Research

The aim of the research was to determine the existence of motivation in students to practice the subject content in chemistry using online tests which were developed using the program Testmoz.

We wanted to examine gender difference in the interest in the use of ICT in teaching or in motivation to practice subject content using online tests.

Based on the goal of the research, the following hypotheses were established:

H1. There is no gender difference in the motivation to use online tests for practicing the subject matter content.

H2. Students will achieve a better quality practice level of the contents for which they were offered the possibility of practicing using online tests prepared in the Testmoz program, due to additional motivation, and they will achieve better results when examining the level of acquisition of the subject content.

III. Research Methodology

A. Sample of Participants

The sample consisted of 68 students of three eighth grade departments of Ljubo Babić Primary School (OŠ "Ljubo Babić"), Jastrebarsko. The composition of the sample by gender is: 36 girls and 32 boys.

B. Research Instrument

The research was conducted using an online test developed in Testmoz. The test consisted of 20 assignments, of which eight were closed-type assignments and 12 open-ended assignments, with a maximum of 32 points. The assignments tested knowledge of chemical formulas of hydrocarbons (7 questions), general formulas of hydrocarbons (1 assignment), description of chemical reactions by equations (5 assignments), calculating the relative molecular mass (2 assignments) and determining the empirical formula (1 assignment) and the properties of hydrocarbons (4 questions). The students were acquainted with the relevant knowledge during the processing of teaching units: 1. Saturated hydrocarbons, 2. Unsaturated hydrocarbons – alkenes and alkynes, 3. Aromatic hydrocarbons – arenes. The correct answers in the online test were evaluated. Incorrect answers did not result in negative points. The research was carried out in the period of two weeks, after processing of the teaching topic "Hydrocarbons", and before the written test. The average time for solving the test was 10 minutes.

C. Procedures of Data Processing

After the research had been carried out, the data collected by the described instrument were entered in the computer program for statistical processing in SPSS 16, and the results were presented graphically in a commercial data processing program, Microsoft Excel.

Open Science Index, Educational and Pedagogical Sciences Vol:16, No:9, 2022 publications.waset.org/10012688.pdf

IV. Results and Discussion

The online test contained a total of 20 questions. The maximum number of points that the students could achieve in the online test was 32. Out of a total of 68 students, 54 students took the test. Such a good response of students who solved the online test can be explained by the motivation to achieve. Namely, according to Atkinson et al. [13], for the school environment, this motive is particularly important, since it points to a desire to carry out the assignment as well as possible.

Students who did not take the online test belong to a heterogeneous group of students, related to their success in chemistry. Furthermore, the reason for not accessing the online test was not the inability to access the technology. All students stated that they have access to the Internet at home, and they were told that they could access online testing at school as well.

Students were offered the possibility of (optional) - an additional way to repeat and practice subject matter content. Since the "new generations" - digital natives, mostly use ICT, it was assumed that they would be happy to use them for educational purposes. For repetition of the material on hydrocarbons, students were offered the possibility to repeat it in the "classical way" - assignments in a workbook (mandatory) and an online test that was not mandatory. Analysis of the data obtained after repetition and testing showed that better results were achieved by those students who repeated and practiced using an online test. What was surprising was the number of repeated accesses to the testing. Some students took the test several times and practiced the subject matter content through it, because this way of practicing was more interesting to them - that was the students' explanation. Also, these same students scored better in the written test compared to the results of previous written tests in the 7th and 8th grade.

The students could access the test for an unlimited number of times. Fig. 1 shows the range of the number of accesses to the test.

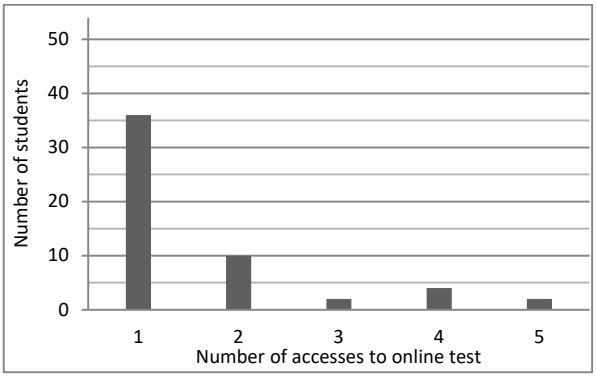

Fig. 1 Graphical presentation of the number of accesses to the online test

The arithmetic mean value (M) of the number of accesses to solving the test is 1.72. 36 students took the test only once, which represented 67% of the students in the research. 33% of the students took the test between two to five times (Fig. 1). Ten students took the test twice, while only two students accessed the online test five times. The average resolution of the test is presented in Fig. 2.

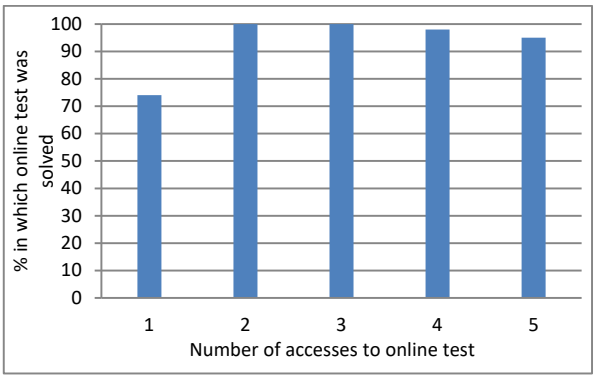

Fig. 2 Graphical presentation of the dependence of the percentage of times in which the online test was solved on the number of times the test was accessed

When first taking the online test, the average test resolution was 74%. During the second and third access, the students solved the test at a rate of 100%. One of the most important components that impacts learning outcomes is motivation. The socio-cognitive theory, developed by Bandura and later refined, comprehensively explains the processes of human learning and motivation as the interplay of personality characteristics, environmental influences, and individual behavior [14]-[16].

Motivated students successfully master the subject content because they apply specific behaviors: they learn, are active during the lesson, ask questions, perform experiments, get involved in projects. Sometimes the students find the material so interesting that they learn it out of pure curiosity, without expecting any reward in the form of a good grade or commendation. In such cases, we say that students are intrinsically motivated, i.e., that they have an internal motivation for learning. Intrinsic motivation is a response to the student's internal needs such as curiosity, the need for knowledge, a sense of competence and growth and development [17].

Extrinsic motivation refers to motivation that has its source outside the student, such as a good test score, grades, teacher's praise, diplomas, medals and other rewards. Behavior is characterized as extrinsically motivated if the behavioral driver lies outside the action itself or more amply expressed: if the person is controlled from outside [17], [18]. Extrinsic motivation connects the successful performance of tasks with consequences that students care about. It is based on reinforcements, feedback, rewards. The consequence that students desire most are good grades. The grade is, along with praise, the most common extrinsic award.

The number of tests solved in a specific range of the percentage of the solving level is presented in Table I.

Multiple solving of the test was achieved by students who solved the test in the first solution in the range of 55% to 70%. All students achieved a better result after solving the test, often higher than 90%. The goal of the students was to achieve a good result on the written knowledge test; we can conclude that the students were extrinsically motivated.

Open Science Index, Educational and Pedagogical Sciences Vol:16, No:9, 2022 publications.waset.org/10012688.pdf

TABLE I
THE NUMBER OF TESTS SOLVED IN A SPECIFIC RANGE OF THE PERCENTAGE OF THE SOLVING LEVEL

% of solving level of online test	Number of tests
0 - 49%	8
50 – 59%	8
60 – 69%	10
70 – 79%	9
80 – 89%	12
90 – 100%	40

Four students solved the online test 100% on their first and only access. The worst-solved test, with 9% resolution, was solved by a student who took the online test only once. According to Vidović et al., students most often state the causes of success or failure, which can be classified into three categories: ability/personality traits, motivation/activities and external factors. Students who are successful in school most often attribute their success to abilities - they do not tend to attribute their success to external factors over which they have no control. Students who experience failure will attribute it to bad luck, and in repeated failure they attribute it to external causes (teachers' attitudes towards the student, the difficulty of the test or assignment, the difficulty of the subject) [17].

There were 36 girls and 18 boys participating in the research. Fig. 3 shows the difference in the percentage (share) of accessing the online test between the girls and boys.

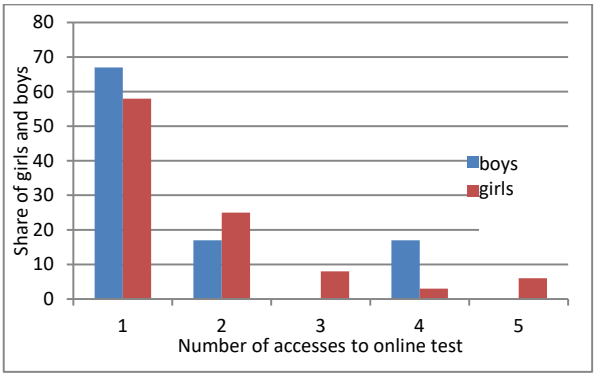

Fig. 3 Graphical presentation of the difference in the percentage of accesses to the online test between girls and boys

Because the distribution of online test access is not distributed normally, nonparametric tests were used to analyze the data. The Median test was used to analyze the difference in access to the online test by gender, and to examine the difference in task performance in students who used online practice tests compared to those who practiced only in the "classical way".

In order to determine the differences in the number of online test accesses between girls and boys, the average number of test accesses was calculated. The average number of accesses to the online test for boys is 1.69, and for girls 1.74. Also, to analyze the difference in access to the online test by gender, the Median test was used. In our case, the median is 1 in both the boys' group and the girls' group. Further analysis for the Median test in which the $\chi 2$-value was calculated for data above and below the median, the value $\chi 2 = 0.1256$ was obtained, which is less than 3.841 (3.841 is the limit value $\chi 2$ with one degree of tolerance at the significance level of 5%). It follows from the above that, with 95% certainty, we can conclude that there is no gender difference between the respondents in this study in the number of accesses to the online test, i.e. there is no gender difference in the interest shown in using digital teaching materials.

The hypothesis H1 - there is no gender difference in the interest to use online tests to practice the subject matter content - is accepted.

A week after taking the online test, students had a written test of their knowledge. The written test tested, as did the online test, their knowledge of chemical formulas of hydrocarbons, general formulas of hydrocarbons, descriptions of chemical reactions by equations, the calculation of relative molecular weight and determination of empirical formula and properties of hydrocarbons. The total number of questions in the written test was 32, and the total number of points was 36. The average grade obtained in the written test by the students who took the online test was 3.98. The average grade of students who had never taken the online test, in the written test was 2.86. The results of the research showed that students achieved better educational results in chemistry when they had access to online tests for repetition and practice in relation to the adoption of subject content which was checked after repetition and practice in the "classical way" - by solving assignments in a workbook or written tasks in worksheets.

The Median test was used in order to examine the existence of a statistically significant difference between groups of respondents (students who did practice exercises for the subject content in the "classical way" and students who practiced the subject content with an online test). The central value (the median) in the group of students who practiced the subject content only in the "classical way" is 3, and the median in the group of students who practiced the subject content using the online test is 4. Further analysis of data in the SPSS program for the Median test calculated $\chi 2$-value for data above and below the median, the value $\chi 2 = 4.2436$ was obtained, which is more than 3.841 (3.841 is the limit value $\chi 2$ with one degree of tolerance at the significance level of 5%). It follows from the above that we can conclude with 95% certainty that students who practiced the subject content with the help of online tests achieved better results when testing their acquisition of the subject content compared to those who practiced only in the "classical way".

The hypothesis H2 – that students will achieve a better quality practice level of the contents for which they were offered the possibility of practicing using online tests prepared in the Testmoz program, due to additional motivation, and they will achieve better results when examining the level of acquisition of the subject content - is accepted [19].

In addition to the above mentioned results, it is important to point out the following advantages of online tests: cost-efficiency (there is no need to print and duplicate worksheets for repetition); accessibility to students at any time at school, from home; ease of changing questions and creating a database

of questions; the speed of obtaining the results, i.e. correct and incorrect answers, and the delivery medium (computer application) is familiar to today's students and draws their attention. Monitoring, assessment and evaluation should be useful to those for whom it is intended, and that is, above all, the students. And that is exactly what the application of online tests created in Testmoz enables.

V. Limitations and Shortcomings of the Conducted Research

The research was carried out on a population of students of the eighth grade in a primary school in the City of Jastrebarsko, which is a city with a population of about 10,000 inhabitants, mostly rural. It would be necessary to repeat the research in larger urban areas and in other parts of Croatia in order to be able to see if there is a difference in the results as a consequence of the life style and habits of students and the available infrastructure. It would also be useful to carry out the research for different subject matters other than chemistry, in order to research whether the type of subject content impacts the motivation level of students for use of technology in teaching.

VI. Conclusion

The research was conducted with three eighth grade classes of Ljubo Babić Primary School (OŠ "Ljubo Babić") in Jastrebarsko. The aim was to determine whether there is motivation in students to practice the subject content in chemistry using online tests prepared in the Testmoz program, and whether there is a gender difference in the use of digitalized teaching materials.

The students accessed the tests in their free time, at home, for an unlimited number of times.

The results of the research showed that the students are more motivated to do subject content exercises when their materials are digitalized. From a total of 68 students, 54 students accessed the test. Also, the students achieved better results in tests of their knowledge in chemistry when online tests were available to them for the repetition and practicing in relation to the tests of the teaching contents that were carried out after the repetition and practicing in "the classical way" – by solving the assignments in a workbook or by written assignments in worksheets. Also, the results of the research show that there are no gender differences in the motivation for practicing of the teaching contents by online tests.

References

[1] Stankov, S., Grubišić, A., Žitko, B. (2004a). E-learning paradigm & Intelligent tutoring system. In: Kniewald, Z. (ed.): Annual 2004 of the Croatian Academy of Engineering Croatian Academy of Engineering, Zagreb 21-31.

[2] Khan, B.H. (2001). A framework for Web-based learning. In: Khan, B. H. (ed.): Web-based training. Englewood Cliffs, NJ: Education Technology Publication.

[3] Grubišić, A. (2007). Vrednovanje učinka inteligentnih sustava e-učenja *(Evaluating educational influence of intelligent e-learning systems)*. Master's paper. Split: Faculty of Science, p. 195.

[4] ASTD (2001): A Vision of E-learning for America's Workforce. Report of the Commission on Technology and Adult Learning, http://www.astd.org

[5] Rodek, S. (2011). Novi mediji i nova kultura učenja *(New media and new culture of learning)*. Napredak, 151(1), 9-28.

[6] Ally, M. (2008). Foundations of Educational Theory for Online Learning. U Anderson, T. (ed.), *Theory and Practice of* Online *Learning*. (str. 15-44). Athabasca, Canada: Athabasca University.

[7] Cole, R. A. (2000). *Issues in Web-based pedagogy: A critical primer*. Westport, CT: Greenwood Press.

[8] Rossett, A. (2002). Waking in the night and thinking about e-learning.

[9] Ring, G. & Mathieux, G. (2002, February). The key components of quality learning. Paper presented at the *ASTD TechKnowledge 2002 Conference*, Las Vegas.

[10] Testomoz, https://testmoz.com

[11] Mužić, V., Vrgoč, H. (2005). Vrjednovanje u odgoju i obrazovanju *(Evaluation in Education)*, Hrvatsko-pedagoško-književni zbor *(Croatian Literary - Educational Association)*, Zagreb.

[12] Bognar, L., Matijević, M. (2002). Didaktika *(Didactics)*. Školska knjiga, Zagreb.

[13] Atkinson, J.W., Raynor, J.O. (1978). Motivation and achievement. New York: Wiley.

[14] Bandura, A. (1986) "Social foundations of thought and action: A social cognitive theory". Englewood Cliffs, NJ. Prentice-Hall.

[15] Pintrich, P. R. (2003) "A motivational science perspective on the role of student motivation in learning and teaching context". Journal of Education Psychology, 95, 667-686.

[16] Pajares, F., Schunk, D. H. (2001) "Self-beliefs and school success: Self-efficacy, self-concept and school achievement". In R. Riding & S. Rayner (Eds.). London: Ablex Publishing.

[17] Vizek, V. V., Rijavec, M., Štetić-Vlahović, V., Miljković, D. (2003) "Psihologija obrazovanja" *(Psychology of Education)*. Zagreb: IEP-VERN.

[18] Rheinberg, F. (2004) "Motivacija" *(Motivation)*. Zagreb: Naklada Slap.

[19] Petz, B., Kolesarić V., Ivanec D., "Petzova statistika – Osnovne statističke metode za nematematičare" *(Petz's statistics – Basic statistic methods for non-mathematicians)*, Jastrebarsko: Naklada Slap, 2012.

[20] ISPL Information Society and Education: Linking European Policies. Luxemburg: Office for Official Publications of the European Communities, 15 pp, 2006. https://www.lu.lv/materiali/biblioteka/es/pilnieteksti/izglitiba/Information%20society%20and%20education%20-%20Linking%20European%20Policies.pdf (15.09. 2018)

Open Science Index, Educational and Pedagogical Sciences Vol:16, No:9, 2022 publications.waset.org/10012688.pdf