

## Activities of simulated inquiry-based observations in biology to support the development of higher-level cognitive processes

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### ABSTRACT

The COVID-19 pandemic has challenged teachers and opened the door to how to appropriately teach and evaluate acquisition of knowledge and science skills that examine the procedural and metacognitive dimensions of students' knowledge in an online environment. This thought also launched the project "Learning biology in an epidemiologically adapted research environment" as part of the project "health, economic and educational aspects of the COVID-19 pandemic" (IP-CORONA-2020-12). The goal of the research is to determine the effectiveness of the materials used for the 3<sup>rd</sup> grade of high school in solving tasks that examine procedural and metacognitive levels of knowledge in relation to traditional teaching methods. 181 students of the 4<sup>th</sup> grade of high school took part in the project, in September 2021. they took an online written knowledge test, and 275 students of the 3<sup>rd</sup> grade of high school used the created materials during the 2021/2022 school year. The 3<sup>rd</sup> grade students took the written knowledge test in June 2022. The results of the research show a better overall solution for the written knowledge test of the students of the experimental group, as well as a better solution for the tasks that examine higher knowledge cognitive levels. The analysis of the results showed that the solving of tasks after using the ASIO learning model using the BUBO virtual classroom is overall 32 % more successful while questions from certain cognitive levels have even 45 % better results compared to control groups.

**Keywords:** *higher cognitive level of knowledge; BUBO online learning platform; ASIO model; biology; high school*

### INTRODUCTION

The COVID-19 pandemic has challenged teachers and opened the door to how to appropriate involve students in teaching process and (self) evaluate acquisition of knowledge and science skills that develop the procedural and metacognitive dimensions of students' knowledge in an online environment. This thought also launched the project "Learning biology in an epidemiologically adapted research environment" as part of the project "health, economic and educational aspects of the COVID-19 pandemic" (IP-CORONA-2020-12). The goal of the research is to determine the effectiveness of the learning activities used for the 11<sup>th</sup> grade students (high school) in solving tasks that involve procedural and metacognitive levels of knowledge in relation to traditional teaching methods. With this aim learning results of student taught just by oral presentation during in online environment (control group) were compared whit learning results of students taught by the ASIO model (Activities of Simultaneous Investigations and Observations in in biology ) in the BUBO virtual classroom ( experimental group).

It has been established that the best high school students during the State biology competition had solved high-level objectives tasks with just 10% efficiency in III cognitive domain and 40 % efficiency in II cognitive domain (Begić et al, 2016). The student`s preparation for such a level of competition should include the learning activities that will encourage development of the procedural and metacognitive knowledge. We assumed that by using of the learning activities made within our project will give abilities to students to increase the efficiency in solving of higher-level objective tasks that involved

procedural and metacognitive knowledge and that they will have better results in online test than control group.

## **METHOD**

During the project, learning activities were made following the ASIO model of learning. The objectives used were divided in the concepts with themes: 1. Homeostasis and regulation - concept A, 2. Adaptations during evolution – concept B, 3. Extreme environmental adaptations. - field work simulation. Learning activities were integrated in the BUBO virtual classroom.

To test the effect of the ASIO learning activities control group involved 181 12th grade students that have not been thought by the ASIO model previous years, and experimental group with 275 11th grade students that used learning activities made by the ASIO model during the school year 2021. /2022. Control group students that took part in the project, were tested by an online written knowledge exam in September 2021. The experimental group took an online written knowledge exam in June 2022. after one year of teaching by the ASIO model learning activities in BUBO virtual classroom

In analysis of the written knowledge exam from both groups averages % results were calculated, standard deviations and significancy of results were compared by t-test online calculator (Social Science Statistics, 2022).

## **RESULTS**

The analysis of the results showed that the solving of tasks after using the learning activities within ASIO model on BUBO virtual classroom is overall 32% more successful in experimental group while questions from certain higher cognitive levels of knowledge have been 45% better solved compared to control groups. Higher cognitive domains were better solved in experimental group compared to control in all concepts. Concept B was only one in which I level of cognitive domain have had better score than higher cognitive domains.

## **DISCUSSION, CONCLUSIONS AND DIDACTIC SIGNIFICANCE**

Efficiency of the ASIO methods made within this project has been analysed by using of the results of online written exam that asses higher cognitive domain of knowledge between students that were taught by ASIO learning activities and those taught just by oral presentation. Analysis indicates that percentage of solved tasks is much higher after using of the ASIO methods in the BUBO virtual classes. The results of tasks that includes involvement of III cognitive domain in the concept A in control group are in corelation of results of Begić et al (2016). That work indicate that students during National biology competition have lower results in solving of tasks that involve higher cognitive domain with efficiency of 10 % for tasks of III domain, while our result are much higher and for the concept of field work simulation even 42 % higher compared to control group. Begić et al (2016) indicate that one source of low results in tasks that involved higher cognitive domain is inexperience in solving ones due to inadequate method of teaching students. Due to our results which are even higher that we predicted, especially result of using field work simulation within the ASIO model confirmed that this teaching methods are one that improve failures of frontal teaching.

Zimmerman (2007) points out that the key to scientific thinking is a reflection on the process of acquiring knowledge and changes in knowledge, i.e. the conscious and deliberate coordination of numerous strategic and metastrategic processes and a systematic approach to experimenting and

making conclusions. Within the learning activities of the ASIO model, this type of thinking is encouraged through investigative learning.

The results of our research, which examined the understanding of concepts related to the maintenance of homeostasis in the organism, do not correlate with the conclusions of the work of Črnil (2019), whose research includes an analysis of the understanding of the same concepts. In her work Črnila indicates that the tasks in the State biology competition (2019.) in which the application of these concepts in solving every day's problems and making conclusions are worse solved than the tasks in which the reproduction of knowledge is tested. She states that most incorrect answers in this research are due to of students' insufficient knowledge and methods in teaching where teaching is still predominantly frontal lecturing manner. The aforementioned non-correlation of our with the work of Črnila (2019) indicates that the ASIO teaching model is precise progress and results in a significant improvement in solving tasks of higher cognitive levels that include procedural and metacognitive levels of knowledge. Given that the tasks for the online written tests on the BUBO platform which examine all levels of knowledge, were done according to the recommendation (Radanović et al., 2013), they were easily measurable and contained all the necessary items for analysis that were easily accessible and measurable. Therefore, the tasks can be used in other combinations of online knowledge tests.

Development of critical and scientific thinking involves implementation of active learning methods by using metacognitive and procedural knowledge and skills in live or virtual classroom. Cognitive student's activity is express during individual investigation and making conclusion based on evidence support by reflection of learning processes. This work presents an example of learning activities involving students' cognitive engagement, which is applicable in developing the higher knowledge domain of all specific objectives in subject-related curriculums and interdisciplinary curricula.

## LITERATURE

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