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LABORATORY ACTIVITIES TO INTRODUCE THE QUALITATIVE ANALYSIS OF BIOMOLECULES IN THE COMMON FOOD STUFF – AN EXAMPLE OF INQUIRY-BASED TEACHING IN THE CHEMISTRY CLASSROOM

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ABSTRACT:

The inquiry-based teaching methodologies have important place in the laboratory school practice and science education. Inquire-based learning combines the hands-on activities with student-centred discussion, and, in the same time, promotes the students engagement, collaboration and self-confidence, as well as their critical thinking and problem-solving abilities. Herein we present practical examples of inquiry-based activities for the qualitative determination of the presence of carbohydrates, starch, proteins and vitamin C in common food stuff. The developed activities were realized with the third and fourth grade students from the vocational school (The first technical school, Kragujevac, Serbia). The students were requested to perform the qualitative tests for the determination of starch (Iodine test), reducing sugars (Fehling test), proteins (Biuret test) and vitamin C (Iodine test), prior to the realization of final task where they needed to choose adequate methods and solve real-life conceptually based problems using acquired knowledge and skills. Confirmatory and structured inquiry teaching were applied and the students were equipped with experimental procedures. The applied methodology has been used to reinforce students' existing knowledge and connections with real-life concepts.

Keywords: *inquiry-based teaching; biomolecules; chemistry*

1. INTRODUCTION

Inquire-based teaching is a method where educators guide students through the learning process by posing questions, encouraging exploration, and fostering critical thinking. It promotes active engagement and deeper understanding of the subject matter. The inquiry-based teaching methodologies have important place in the laboratory school practice and science education [1]. They combine the hands-on activities with student-centered discussion, and, in the same time, promote the students engagement, collaboration and self-confidence [2], as well as their critical thinking and problem-solving abilities. There are five inquiry-based teaching methods, namely simulation, field study, project, demonstration of discrepant events and experiment [3]. Experiment takes central place in doing investigation in chemistry classroom. The experiment offers controlled environment

for experimentation, discovery, and the validation of scientific theories. By combining laboratory activities and research, more abiding feature is created in which teaching and learning become an active cooperative process. The framework created in this way includes active students' engagements in the learning scientific concepts with the focus on observations, experience, adoption of problem-based learning process, permanent development of skills and autonomy through experience [4]. The methodology employed for learning chemistry in Serbian education is based on the traditional teaching method and the little attention has been placed on the activities that will engage students in the experimental design process. Taking all above in consideration, herein we present the results of the application of inquire-based activities for the learning concepts from the biochemistry (determination of the presence of carbohydrates, starch, proteins and vitamin C in common foodstuff) on the students' personal reflections and attitudes towards this learning model.

2. SAMPLE AND METHODOLOGY

Herein we present practical examples of inquiry-based activities for the qualitative determination of the presence of carbohydrates, starch, proteins and vitamin C in common food stuff. The developed activities were realized with the third and fourth grade students from the vocational school (The first technical school, Kragujevac, Serbia, N=85, girls 63, boys 22). The students were working in small groups (4 students in one group). The activities were realized at the laboratories of Faculty of Science (Department of chemistry, University of Kragujevac), under supervisory of professors and PhD students whose have rich experience in the implementation of different kinds of active learning methodologies in the chemistry classroom. At the first workshop, the students were requested to perform the qualitative tests for the determination of starch (Iodine test), reducing sugars (Fehling test), proteins (Biuret test) and vitamin C (Iodine test), prior to the realization of final workshop where the given tasks required from students to choose adequate methods and solve real-life conceptually based problems using acquired knowledge and skills. Confirmatory and structured inquiry teaching were applied and the students were equipped with experimental procedures. The applied methodology has been used to reinforce students' existing knowledge and connections with real-life concepts. After the activities were realized, the survey related to the students' personal reflections and attitudes toward inquire-based activity application in learning chemistry contests was given to the students.

3. RESULTS AND DISCUSSIONS

In a confirmatory inquiry activity the teacher provides research questions and procedure, and students are asked to confirm a previously taught relationships. From the other side, in structured inquiry, the research questions and procedure are also provided but students don't know the expected outcomes of the given problems [5]. In this research, we have offered students to learn the concepts from the biochemistry (presence of different biomolecules in common food stuff) at different levels of inquiry – namely combination of confirmatory and structured inquiry, as indicated in Table 1. It is important to

emphasize that, in all levels, students analyzed data to find solutions for research questions but the levels of inquiry differs in the quantity of information provided by teachers.

Table 1. Levels of inquiry applied in our study.

Inquire level	What Teachers Provides	Examples in our study
Confirmatory	Question Method Solution	After learning about biomolecule examples and their presence in everyday life, students practice the chemical tests for the detection of the presence of the selected examples (reducing sugars, ascorbic acid, proteins and starch). Data analysis: Qualitative evidence of a reactions for each class of biomolecules (recorded color changes of the reagents used in the chemical tests).
Structured	Question Method	To the students, previously equipped with procedure for determination of biomolecules in the food samples, the problems related to the real-life concepts and presence of biomolecules in common food stuff are given to solve. Data analysis: Distinguishing between qualitative chemical tests necessary for the determination of presence of reducing sugars, vitamin C, starch and proteins in food samples (Coca Cola classic, Coca Cola zero, natural juice, flour, and milk).

At the initial workshops, students learn how to perform qualitative tests for the determination of biomolecules (Iodine test for starch, Fehling test for reducing sugars, Biuret test for proteins, Iodine test for vitamin C). The students previously were equipped with the knowledge about using chemical laboratory glass and equipment and safety rules in laboratory work. During activities, students followed given experimental procedures and observed changes of the colors in the performed chemical tests. After completing the experimental work, students wrote a procedure, turning to the important practical aspects of the experiments. Even at the first workshop, students get benefits from the activities reflected in achievement of starting point for development of their own experiments and enjoying of performing experiments in groups. Confirmatory activities are helpful in reinforcing challenging chemical concepts, as well as in creating better students' focus on a specific laboratory tests. After the first workshop was realized, at the second workshop, the following chemical problems were given to the students:

Problem 1. There are test tubes with samples of the natural orange juice and flavored orange juice. By using appropriate reaction find out which sample is containing natural juice.

Problem 2. There are test tubes with Coca-Cola Classic and Coca-Cola zero. By using appropriate chemical reaction find out which sample contains Coca-Cola Classic.

Problem 3. At your working place you will find the samples of flour and milk. Using appropriate reagents, confirm the presence of:

a) sugar b) protein c) starch in appropriate food sample.

For instance, to solve problem 1, students needed to know that natural orange juice contains vitamin C and then to apply reaction for its identification in the sample. Problem 2 required from students to apply Fehling reaction for the qualitative identification of reducing sugar in classic Coca Cola sample, since the Coca Cola zero doesn't contain sugars. In order to solve the problem 3, it was necessary for students to recognize that flour sample contains starch and to apply iodine test for its identification; that milk sample contains proteins and to apply Biuret test to identify them, as well as reducing sugar lactose and to apply Fehling reaction for its identification. The presented problems required from the students to propose an experimental procedure in order to solve them and, in the same time, to combine practical knowledge with theoretical knowledge about biomolecules and their presence in common food stuff. Students were working in small groups and in order to solve the problems, they had to work together, communicate and discuss possible solutions. According to the teachers' personal opinions and observations established during realization of workshops, some negative and positive experiences are summarized in Table 2.

Table 2. Positive and negative experiences during realization of workshops according to the teachers' opinions

Positive experiences	Negative experiences
Students expressed interest during working on the given topics. Most of them were motivated to accomplish given tasks and achieve good results.	In several cases, lack of the necessary content knowledge.
Students experienced skilled and successful accomplishment of the practical part.	Some students preferred more to work independently.
Matured, environmental-conscious approach on the students' part.	Some students felt pressured during realization of activities (fear from unsuccessful accomplishment of the tasks).
Better connections with real-life concepts.	

After all groups finished activities, the following survey list was administrated to the students (Table 3). Table 3 also indicates the students' responses on given statements.

Table 3. Survey – Students’ attitudes and personal reflections towards inquire-based teaching implementation in chemistry classroom

Statement	Fully agree (%)	Agree (%)	Disagree (%)	Fully disagree (%)	Agreement with the statement (%) N=85
I’ve enjoyed doing laboratory activities.	20	64.7	8.2	7.1	84.7
These activities helped me to understand chemistry contents in everyday life-concepts.	35.3	47.1	16.5	1.1	82.4
I’ve enjoyed doing activities in a group.	56.5	43.5	0.0	0.0	100
I felt pressured to do activities.	0.0	10.6	34.1	55.3	10.6
I would like to have more teaching and learning activities based on inquiry	29.4	57.6	13.0	0.0	87

The students’ answers enabled us to find out whether students considered inquiry-based teaching important in their motivation to study chemical contents and how important for them was group work in the performance of activities. From the results obtained in our study, it can be concluded that the introduction of inquiry-based teaching into the chemistry classroom led to a significantly better acquisition of chemistry concepts related to biochemistry, and produced positive students’ attitudes towards chemistry and laboratory activities.

4. CONCLUSION

When it comes to suggestions for chemistry teaching, the varied teaching models and approaches available for inquiry-based teaching could be included in schools as a suitable classroom practice. Herein we described the examples of inquiry-based activities for the qualitative determination of the presence of carbohydrates, starch, proteins and vitamin C in common foodstuff that were applied in the work with the students from a vocational school in order to follow their personal reflections and attitudes toward inquire-based activity application in learning chemistry contests. The influence of applied activities on the reinforcement of students' existing knowledge and connections with real-life concepts was also studied. According to the obtained results, it can be concluded that introduction of inquiry-based teaching into chemistry classroom led to a significantly better acquisition of chemistry concepts related to biochemistry, and produced positive students' attitudes towards chemistry and laboratory activities.

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