

THE EFFECTIVENESS OF IMPLEMENTING INQUIRY ACTIVITIES INTO THE TEACHING PROCESS IN THE PHASE OF REVISING AND DEEPENING THE LEARNING CONTENT

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Abstract

The aim of research was to verify the effectiveness of implementing the inquiry-based teaching (IBT) into the teaching process of chemistry in secondary school in the phase of revising and deepening the previous-year learning content. The results of the research confirmed a significant difference on the level of knowledge and skills between the experimental group students (N=143) where the IBT was implemented and the control group students (N=149) where traditional teaching methods were implied.

Keywords: *changes in chemical reactions, inquiry-based teaching, learning content, secondary school students.*

Introduction

In Slovakia, the request of inquiry for the subject of chemistry is anchored in the National Education Programme for Lower Secondary Education (ŠVP ISCED 2, 2014). The subject of chemistry should have a research and an activity character, students should learn through their own experience about the properties of substances, natural relations of their behaviour and their interaction. This request is also related to the constantly deteriorating results of Slovak students in international comparative measures OECD PISA. Slovak students have a good command of natural science knowledge on the level of remembering and understanding, but they cannot think independently about natural science phenomena and connections, observe them, create hypotheses, find and design solutions, interpret collected data, form conclusions and use evidence when arguing (OECD, 2007, 2016). One of the possible ways of solving this problem is the implementation of inquiry-based teaching (IBT) into the teaching process.

The results of many studies pointed out the effectiveness of IBT when acquiring knowledge with regard to the increase of conceptual understanding of concepts and knowledge, development of critical thinking, sustainability of knowledge, development of skills – both scientific and cognitive, increasing motivation and interest as well as forming positive attitudes towards the subject (Akçay & Yager, 2010; Brickman,

Gormally, Hallar, & Armstrong, 2009; Bruder & Prescott, 2013; Furtak, Seidel, Iverson, & Briggs, 2012; Hattie, 2009; Marshall & Horton, 2011; McLoughlin, Finlayson, & van Kampen, 2012; Minner, Levy, & Century, 2010; Song & Kong, 2014; Wang, Wu, Yu, & Lin, 2015). These studies focused on the IBT implementation in the phase of approaching the learning content, which is also related to the definition of inquiry.

As the traditional approach to teaching in Slovak schools shows knowledge acquisition only on the level of lower-order thinking, which may assume also a lower knowledge sustainability, our goal was to reach a required level of knowledge acquisition after revising and deepening learning content acquired in the previous year – gained in the following year by means of implementation of the created inquiry activities for the IBT. The implementation of IBT in this phase of teaching process enables to point out the problems of the current education system in Slovakia, that are related to knowledge sustainability and also the influence of the IBT on the level of knowledge acquisition.

Research Methodology

General Characteristics

The main aim of the research was to verify the effectiveness of implementing IBT into the teaching process during the phase of revising and deepening the learning content from the previous year within the “Changes in Chemical Reactions” thematic unit in students of the 8th grade of secondary schools.

A pre-test-post-test design was applied for the purposes of the research.

The research was conducted in the selected secondary schools during the school year of 2017/2018.

The research sample comprised of eleven teachers and 292 students of the 8th grade from eleven classes of secondary schools. The experimental group consisted of five teachers and 143 students and the control group consisted of six teachers and 149 students. The gender composition of the groups was the following: the experimental group with 63 young men and 80 young women and the control group with 72 young men and 77 young women.

Procedures

Pre-tests were realized at the beginning of the research to find out the input knowledge of students – what the students remembered from the “Changes in Chemical Reactions” thematic unit which was taught during the previous school year. Based on the results of the pre-tests, the classes were divided into experimental and control ones. Teachers were also taken into consideration, so that the equality in terms of IBT skills was secured.

Consequently, the teaching process started. In experimental classes the created inquiry activities were used within the revising and deepening of the learning content from the “Changes in Chemical Reactions” thematic unit – five activities overall: “Exothermic and Endothermic Reactions” and four activities aimed at “The Factors Affecting the Rate of Chemical Reactions”. Inquiry activities (i.e. the Methodological Sheets for Teachers and Worksheets for Students) were created based on the 5E model (Bybee et al., 2006)

and they were intended for the guided inquiry. In control (comparative) classes, teachers used their own way of teaching during the revising process – traditional teaching methods were implemented such as questions and answers method, oral revision, written revision, work with a textbook, demonstration experiments and laboratory works.

After the revising and deepening of the learning content, the post-tests were taken in all of the classes.

Research Instrument

Standardized cognitive tests were used as a research instrument for the pre-tests and post-tests. The tests were comparable, they included the learning content of the “Changes in Chemical Reactions” thematic unit according to the content and performance standards defined in *ŠVP ISCED 2*. They consisted of ten items which were aimed at the following levels of cognitive field, based on the revised Bloom taxonomy (Anderson, Krathwohl, et al., 2001): remembering (1 item), understanding (4 items), applying (4 items) and analysing (1 item).

Data Analysis

When processing data, the tools of phenomenological analysis, descriptive and inductive statistics were used (Kolmogorov-Smirnov test to determine the normality of data distribution and a nonparametric Mann-Whitney U-test to verify the hypotheses of the research).

Research Results

Kolmogorov-Smirnov test confirmed that the gained data ($p < .05$) are not normally distributed, thus we used a nonparametric Mann-Whitney *U*-test to verify the main hypothesis. For statistic verification the main hypothesis was formed as follows:

H_0 : There is no significant difference between the level of knowledge and skills of the experimental group students and the control group students after revising and deepening the learning content.

H_a : There is a significant difference between the level of knowledge and skills of the experimental group students and the control group students after revising and deepening the learning content.

Here, level is understood as an increase of knowledge and skills in cognitive field on the following levels – remembering, understanding, applying and analysing.

The results of the statistic verification of the main hypothesis are listed in Table 1.

Table 1. The results of the statistic verification of the main hypothesis.

Statistics	Value	Description	Conclusion
Z	-6.095*	H_0 rejected	There are differences
Asymp. Sig. (2-tailed)	.001		

*. The main difference is significant at the .05 level.

Conclusions and Implications

Statistic verification of the main hypothesis proved that in the phase of revising and deepening the learning content the IBT was more effective than traditional approach to teaching considering the higher level of students' knowledge and skills. It was particularly proved in the items aimed at the higher-order thinking and with the students with lower academic achievement (those with grades of 3 and 4). The given findings can help improve the results of Slovak students in international measures OECD PISA. It is proved also by the conclusions of the national report PISA 2015: "The way of teaching natural science subjects significantly influences the level of scientific literacy in students (Miklovičová, Galabová, Valovič, & Gondžúrová, 2017)."

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