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The Effects of the Implementation of the Problem Solving Learning Method in Teaching Natural Sciences

Extended summary

The rapid scientific and technological development that marked the beginning of the 21st century is primarily caused by the new discoveries in the field of natural sciences. However, research has shown that primary and secondary school students around the world do not have a positive attitude towards natural sciences (Hacieminoglu, 2015), while problems with understanding academic content (Hacieminoglu et al, 2009), the self-regulation of learning (Pintrich, 2000), and low academic achievement in this field (Weinburgh, 1995) have also been reported. Given that these problems are mainly the consequence of the traditional receptive teaching (Oh & Yager, 2004), in recent years the educational systems around the world have turned toward the constructivist approach when it comes to the teaching of natural sciences (Elkind, 2004).

The problem-based teaching method is one of several methods that have emerged from the constructivist approach and previous research has shown that its implementation has a positive impact on the acquisition of new knowledge with understanding (Minner et al., 2010), development of the self-regulation of learning (Linn et al., 2003) and a more positive attitude toward leaning (Demirel & Turan, 2010), as well as on students' academic achievement (Nikolić, 2018). Consequently, the aim of this paper was to compare the effectiveness of the problem-based teaching method with the traditional receptive teaching in the field of natural sciences. In accordance with this aim, four research hypotheses were proposed: compared to

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the traditional receptive teaching, the problem-based teaching method promotes better understanding of the academic content (H1), a more positive attitude of students toward natural sciences (H2), an improved self-regulation of learning (H3), and a better academic achievement of students in the field of natural sciences (H4). As academic achievement was considered solely as a quantitative aspect of students' performance, understanding of the learning content, as one of the levels of the qualitative aspect of students' performance, was considered in a separate hypothesis. In order to verify the four hypotheses, a meta-analysis was conducted.

The meta-analysis is a quantitative research technique within which, in order to verify the research hypotheses, a thorough literature review is conducted in order to find scientific papers elaborating on the previously conducted experimental studies that tested these hypotheses. The research results presented in these papers are then used to calculate the Effect Size (ES) values (DeCoster, 2004). For the purpose of this meta-analysis, the results obtained from 23 scientific papers were used. The overview of these research papers and the corresponding ES values are presented in Table 1.

Table 1. The overview of the research papers and the corresponding ES values used in this meta-analysis.

Research paper	ES(H1)	ES(H2)	ES(H3)	ES(H4)
Aidoo et al., 2016	/	/	/	1.78
Akinoglu & Tandogan, 2007	/	0.24	/	1.25
Atan et al., 2005	/	/	/	0.28; 0.01
Benli & Sarikaya, 2012	/	/	/	5.07
Bulgin et al., 2009	0.82	/	/	/
Celik et al., 2011	/	/	/	1.16
Folashade & Akinbobola, 2009	/	/	/	1.76; 1.22
Galand et al., 2012	0.16; 0.40	/	0.64	/
Gurses et al., 2015	/	/	/	0.51
Horak & Galluzzo, 2017	/	-0.39; 0.44; 0.37; -0.18; -0.28	/	0.44
Inel & Balim, 2010	/	/	/	0.37
Iqbal et al., 2017	/	/	/	1.57
Koray & Koray, 2013	0.47	/	/	/
Selcuk & Caliskan, 2010	/	0.19; 1.57; 0.65	/	/
Selcuk & Caliskan, 2013	/	/	/	0.32
Sindelar, 2010	/	/	/	0.44
Sungur et al., 2006	/	/	/	1.53
Sungur & Tekkaya, 2006	/	/	0.52; 0.40	/

Tarhan & Acar-Sesen, 2013	9.56; 2.31	/	/	/
Tosun & Senocak, 2013	/	-0.01; -0.09;-0.04; 0.08; 0.85; 0.47; 0.60; 0.84	0.29; 0.14; 0.26; -0.07; 0.06; 0.06; 0; 0.36; 0.75; 0.77; 0.50; 0.70; 0.71; 0.52; 0.15; 0.70	/
Uce & Ates, 2016	/	/	/	1.94
Wulansari et al., 2018	/	/	/	1.94
Zejnilagić-Hajrić et al., 2015	/	/	/	1.44

Explanation: ES(H1) values are used for the verification of hypothesis H1, ES(H2) values are used for the verification of hypothesis H2, ES(H3) values are used for the verification of hypothesis H3 and ES(H4) values are used for the verification of hypothesis H4.

On the basis of the ES values presented in Table 1, the corresponding mean ES values were calculated. The obtained mean ES values are as follows: the mean value of ES(H1)= +2.29, the mean value of ES(H2)= +0.31, the mean value of ES(H3)= +0.31 and the mean value of ES(H4)= +1.27.

Since all four mean ES values are positive and higher than +0.2, all four hypotheses have been verified. Furthermore, the mean values of ES (H2) and ES (H3) are in the range of +0.2 to +0.4, representing small ES values, while the mean values of ES (H1) and ES (H4) are greater than +0.6, representing the large ES values. This implies that the positive effects of the application of the problem-based teaching method in terms of promoting a better understanding of the academic content and a better academic achievement in the field of natural sciences will be very pronounced and easily observable after a relatively short period of application. On the other hand, the positive effects of the application of the problem-based teaching method, when it comes to promoting a more positive attitude and the development of self-regulation of the learning of natural sciences, are small, but not negligible, with a tendency to become more pronounced over time. These results confirm the great potential of the problem-based method for improving the quality of teaching in the field of natural sciences.

Keywords: problem-based learning, receptive teaching, natural sciences, meta-analysis.

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