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TEACHING STRATEGIES FOR PROMOTING HIGHER ORDER THINKING SKILLS: A CASE OF SECONDARY SCIENCE TEACHERS

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ABSTRACT

Promoting students' higher order thinking (HOT) is the main aim of all education studies and programs. Past research in science education has indicated that effective teaching strategies play a vital role in improving these skills among students. This study aimed at investigating strategies used by secondary science teachers in science teaching as well as to determine the association between the strategies used and variables such as gender and years of experience. The Strategies Use Survey Questionnaire (SUSQ) was developed and consisted of 31 questions in the form of a 5- point Likert scale and distributed among 212 7th grade science teachers in the Iraqi-Kurdistan region. Data were analyzed by adopting descriptive and inferential statistics such as *t*-test and one-way ANOVA. Findings of the study indicated that the most popular strategy among 7th grade science teachers is the strategy for acquiring knowledge which focused more on memorizing basic concepts in science, while the least used strategy by science teachers is the strategy for applying knowledge such as problem solving and hands-on activities. Moreover, gender and experience were found to be significant factors for teaching strategies used among study participants ($p < 0.05$).

Keywords: **Teaching strategies, Higher Order Thinking Skills, Teaching science, Education, Iraqi Kurdistan region**

INTRODUCTION

Learning is not in doing, it is in thinking about doing (Dewey, 1933). Research suggested that higher order thinking skills (HOTS) are essential for effective learning and form a central goal for science education (Avargil, Herscovitz, & Dori, 2012). The main component of the present reformation in science education is the shift from the central traditional teaching methods for Lower Order Thinking Skills (LOTS) to Higher Order Thinking Skills (HOTS) (Avargil et al., 2012; Constantinou & Kuys, 2013; Karami, Pakmehr, & Aghili, 2012; Rotgans & Schmidt, 2011; Thitima & Sumalee, 2012). These higher cognitive skills are activated when students encounter unfamiliar problems, uncertainties, questions, or dilemmas. Successful applications of the skills in the science classroom result in explanations, decisions, performances, and products that are valid within the context of available knowledge and experience that promote continued growth in these and other intellectual skills.

Yao (2012) asserted that one of the recommendations of the National Research Council's study (NRCS) on facilitating HOT among students is that teachers must create an environment where students feel comfortable sharing their ideas, invention and personal meaning. More specifically, the science teacher should use the teaching methods requiring active participation of students, by engaging them in generating questions, representing their understanding, solving complex problems and reconstructing their own thinking (Albaaly, 2012; Panasan & Nuangchalerm, 2010; Şimşek & Kabapınar, 2010). Participating students in such class activities would improve their higher cognitive skills that would further help them to become better decision makers and solve problems in their daily life situations. In addition, an increasing body of research has focused on the relationship between the use of effective teaching methods and students' cognitive skills (Constantinou & Kuys, 2013; Karami et al., 2012; Rotgans & Schmidt, 2011; Thitima & Sumalee, 2012; Williams, 2000). Besides, past literature emphasized that teaching strategies are affected by some factors such gender, experiences, and qualification (Bülent, Mehmet, & Nuran, 2015; Hamzeh, 2014).

However, recently, in the context of the Iraqi- Kurdistan region, several important modifications have been made to the secondary science curriculum, as the revamped curriculum focuses largely on prompting students' higher cognitive skill (Vernez, Culbertson, & Constant, 2014). Hence, after three years of educational system reformation in Kurdistan, researchers asserted that students in basic education are lacking in HOTS (UNESCO, 2011; Vernez et al., 2014). Therefore, supporting the idea that teaching strategies should facilitate the transition of students' knowledge and skills into responsible action, regardless of their upcoming role in society, this study aimed at investigating the strategies used by science teachers to teach higher cognitive skills in science learning as well as to determine whether there are differences in using the teaching strategies by science teachers according to gender and years of experience.

LITERATURE REVIEW

Higher Order Thinking Skills

Thinking is a general and extensive term used to describe intellectual functions. Because thinking is a mental process, it cannot be observed directly, but some action reflects thinking and this is known as cognitive skills (Ozgelen, 2012). There are two types of cognitive skills; lower order thinking skills (LOTS) and higher order thinking skills (HOTS). In particular, the skills that involve acquiring knowledge and understanding knowledge are categorized under LOTS, while the skills requiring students to applying and evaluate knowledge are known as HOTS. HOT can be conceptualized as a non- algorithmic, complex mode of thinking that often generates multiple solutions to the proposed problem (Norman, 2009). Newman (1990) distinguishes between lower and higher order thinking. His definitions were derived from observations in classrooms and interviews with teachers and department chairs in five high schools selected because of their departmental efforts to emphasize higher order thinking in social studies classes. From this experience he concludes that lower order thinking demands only routine or mechanical application of previously acquired information such as listing information previously memorized and inserting numbers into previously learned formulas. In contrast, higher order thinking challenges the student to interpret, analyze, or manipulate information.

However, the importance of HOT makes it a priority in each classroom (Davidson & Worsham, 1992; Zawilinski, 2009). In order to achieve this goal teachers should use effective teaching methods that require the students to use varied cognitive skills (Chapman & Aspin, 2013; Voica & Singer, 2011). According to Miri, David, and Uri (2007), there are two steps to improving HOTS among students. First, is to create an environment for students to explore more about the complex problems by asking open-ended questions. Second, is creating opportunities for all students to think about their own thinking through group activities.

Teaching Higher Order Thinking Skills

Research plays an important role in developing strategies that foster the kind of deep conceptual understanding that is transferable to various academic contexts and real life problems (Davidson & Worsham, 1992; Zawilinski, 2009). In order to achieve this goal teachers should use effective teaching methods that require the students to use varied thinking skills (Chapman & Aspin, 2013; Voica & Singer, 2011). Research advocated that effective strategies for developing students' HOT should have the following characteristics:

- Activating the student's prior knowledge; activating student's prior knowledge would assist them to make connections between the previous knowledge and the new information they will be learning. By tapping into what students already know through asking critical questions, teachers can support students in the learning process (Chin & Brown, 2002).

- Using classroom activities; these will provide students with background science information, straightforward steps, and gives them the opportunity for hands-on inquiry for seeking science inspiration. Many of these activities can be prepared and completed in a short time, making them easy to integrate into a classroom setting (Bilgin, 2006; Marshall & Horton, 2011).

- Grouping approach; sharing experiences in small group activities will improve students' knowledge and help them to apply the acquired knowledge into real life situations.

- Assessment forms; science teachers should use different forms of assessment such as alternative assessment and evaluation approaches (Miri et al., 2007; Zohar & Schwartzer, 2005).

Several efforts focused on effective strategies on the development and enhancement of HOT, in which particular strategies such as inquiry, problem solving and the learning cycle have been recommended by the past studies to improve students' HOT in science learning (Miri et al., 2007; Taasoobshirazi & Farley, 2013). Many researchers have noted that a different inquiry based learning model encourages students to use cognitive skills such as exploration, reflection and sharing of ideas (Albaaly, 2012; Gillies, Nichols, Burgh, & Haynes, 2014; Harter, 2007). Both students and teachers benefit from the inquiry approach. By providing cognitive scaffolds that help student to activate HOT skills teachers benefit when students later exhibit independent learning. Besides, problem solving is another strategy recommended by several researchers to develop students' exercise of HOT skills (Bushman & Peacock, 2010; Chapman & Aspin, 2013; Qin, 2011). It is a constructive approach that can promote students' involvement and active learning. Thus, using problem solving strategy in teaching science would enable students to generate their own knowledge as besides enhancing higher thinking skills (Hmelo & Ferrari, 1997; Lawson, 1995). Finally, the learning cycle is an effective strategy to promote students' HOTS since one of the foundational premises of constructive learning is that learners have to construct their own knowledge individually and collectively (Dogru-Atay & Tekkaya, 2008; Singer & Moscovici, 2008; Voica & Singer, 2011). However, all of these effective teaching strategies encourage students to devise the questions, seek information, solve complex problems and reconstruct their own thinking.

Moreover, based on the theories of cognitive development such as Bruner's theory and Gagne theory (Bibergall, 1966; Johnson, 2008; Ozgelen, 2012), research identified three main constructs of cognitive development. First, acquiring knowledge; this construct can be improved through activating students' prior knowledge or retrieving relevant knowledge from long term memory. Besides, students can gather the information in order to understand the phenomena, by using basic thinking skills such as defining terminology, classifying and comparing objects (Aktamis & Yenice, 2010) which are lower order thinking skills (LOTS). However, these basic skills play a critical role in supporting development of HOT skills (Zohar & Schwartzer, 2005). Second, applying knowledge; students must be encouraged to work with data or scientific material using different thinking skills to move to deep understanding of the usefulness and applicability of this scientific material to everyday life, by using more complex cognitive skills such as formulating hypothesis, collecting the data and critiquing (Lati, Supasorn, & Promarak, 2012; Qin, 2011). Third, reflection on knowledge: this construct requires students to use higher level of cognitive skills such make judgment about what has happened and suggesting another way to solve the problem (Phan, 2009; Zachariades, Christou, & Pitta-Pantazi, 2013).

METHOD

Research Design

This study employed a cross-sectional study design that was carried out to investigate the strategies used by science teachers to teach higher cognitive skills in science education in the Iraqi Kurdistan region. In this study, the researcher used survey questionnaire method to collect the data from science teachers.

Participants and Setting

Survey method was used to collect the data of the study. The study was conducted among seventh grade science teachers in Duhok city in the Iraqi-Kurdistan region. Raosoft sample size calculator software available from the website http://www.raosoft.com/samplesize.html was used for estimating sample size directly by entering the general population size with 95% confidence interval. The estimated sample size was 194 7th grade science teachers out of the 371 science teachers who teach 7th grade students in government schools in Duhok city. In order to minimize erroneous results and increase the study reliability, the target sample size was increased to 212.

Instrument

In order to identify the strategies uses by 7th grade science teachers to teach their students HOT, the researcher developed a strategies use survey questionnaire (SUSQ) consisting of 36 questions divided into two parts: the first section elicited demographic information about teachers with regard to their gender and years of experience. While the second part served to identify the strategy used by 7th grade science teachers in science. This part consisted of (34) questions in the form of 5-piont Likert scale (1 = always to 5 = never) based on the constructs of cognitive development. Items (1-15) of the questionnaire measured the strategies used for acquiring the knowledge aimed at improving students' lower order thinking skills. Items 16-23 of the questionnaire measured the strategies used by science teachers for applying knowledge, while items items 24-34 concerned reflection on knowledge strategies in which employing these strategies aid students to improve their higher cognitive skills in science learning.

A forward - backward translation procedure was applied by two linguistic experts from Iraqi Kurdistan region for translating the English version of the strategies use survey questionnaire into the Kurdish language. Instrument reliability was piloted with 88 7th grade science teachers in the Iraqi Kurdistan region. The questionnaire reliability was identified by internal consistency coefficient ''Cronbach's alpha'' methods (Christmann & Van Aelst, 2006). This method is based on calculation of the correlation coefficient between the different items on the same questionnaire. Table 1 shows Cronbach's alpha results for three proposed constructs. As shown in Table 1, the initial Cronbach's alpha coefficients for the applying knowledge construct (.679) is below the .70 threshold value. In order to increase the reliability coefficient, the constructs were purified by dropping items with the lowest item-to-total correlation. Therefore, 3 items were dropped. After excluding unreliable items, the revised items demonstrated coefficient alpha values of each construct and for overall questionnaire were within the acceptable range as in Table 1.

Thus, the final SUSQ consisted of 31 items that were further validated and critiqued by 11 experts in science education, measurement and evaluation. Based on the experts' feedback, minor modifications were made to the questionnaire items.

Table 1
Reliability Analysis (Cronbach's Alpha Coefficient) For the Strategies Use Questionnaire

Construct	No. of items	Cronbach's alpha	No. of items	Revised reliability
Acquiring Knowledge	15	.782	14	.794
Applying Knowledge	9	.679	8	.718
Reflection on Knowledge	10	.715	9	.739
Whole SUQ	34	.893	31	.899

Data Collection

The data collection was done by self-administration the final version of the SUSQ after getting ethical approval from the Ministry of Education in Duhok city in order to conduct the study. The questionnaire was distributed among 212 7th grade science teachers. The participants were asked for their willingness to participate in the study and once verbal consent was obtained, the essential instructions and information about how to fill-up the questionnaire were explained to them. The participants were given enough time to answer all questions as the questionnaires were collected after one week of the administered date.

Data Analysis

The data obtained for this study were analyzed by adopting descriptive and inferential statistics such as *t*-test and one-way ANOVA for examining any significant differences in using teaching strategies among participants with relation to their gender and years of experience by using the Statistical Packages for the Social Sciences (SPSS) Version 21.

RESULTS

The questionnaire was delivered to 212 7th grade science teachers; the survey received a high response rate of 81.1%. The participants' demographic characteristics are presented in Table 2. The sample finally consisted of 57 males and 115 females. All the participants have 10 years of experience and above as indicated in Table 2. In order to identify the most popular strategy among 7th grade science teacher and which construct they focus on in science, the item frequency and percentage was computed for each construct as in Table 3.

Table 2
Distribution of the Sample According to Gender and Expertise

Variable		Frequency	Percent (%)
Gender	Male	57	33.1
	Female	115	66.9
Years of Experience	Above 25	24	14.0
	20-25	36	20.9
	15-20	52	30.2
	10-15	60	34.9
	Total	172	100

Table 3
Results for Strategies Used By Science Teachers

Construct	Mean ±*SD*	Range	Skewness	Kurtosis
Acquiring knowledge (Total)	44.24 ±7.131	37.00	.311	.271
Applying knowledge (Total)	20.22 ±5.227	17.00	-.133	-.9107
Reflection on knowledge (Total)	24.45 ±5.63	20.00	-.772	-.244

The teachers' responses to the strategy use questionnaire indicated that 7th grade science teachers focus more on teaching students basic concepts by using strategies for acquiring knowledge (M = 44.24 ±.13) and reflection on knowledge strategies use (M = 24.45 ±5.63). While the least used strategy is for applying knowledge (M = 20.22 ±5.22). Moreover, in order to investigate the strategies used by science teachers according to their gender independent samples t-test was used as in Table 4.

Table 4
Results of t-Test for Strategies Use Constructs

Variable	gender	N	Mean	Std. Deviation	*t*	*p* value
Acquiring Knowledge	male	57	46.5088	4.72880	3.000	.003
	female	115	43.1217	7.83956		
Applying Knowledge	male	57	21.3684	4.54592	2.035	.043
	female	115	19.6609	5.46422		
Reflection on Knowledge	male	57	23.0526	4.39732	2.665	.008
	female	115	26.6609	6.02318		

Table 4 shows that there is a significant difference between the male and female on strategies use for teaching 7th grade science in the Iraqi-Kurdistan region ($p < .05$). As for the acquiring knowledge construct the mean score for male (46.50) participants was significantly higher than for female participants (43.12) with $p = .003$). While for applying knowledge ($t = 2.035$, $p < .05$) as well as for reflection on knowledge strategies ($t = 2.665$, $p < .05$) the mean for male science teachers was significantly higher than for female science teachers for applying knowledge construct, which was conversely with the reflection on knowledge construct.

However, to explore the differences between science teachers' score in the strategy use questionnaire based on their years of experience, one-way ANOVA analysis was used. The assumption of ANOVA was fulfilled such as the homogeneity between study variables (p value > .05). Table 5 shows the mean and standard deviation for each construct based on participants' years of experience.

Table 5

Teaching Strategies among Science Teachers with Different Years of Experience

Variable	Years of experience	N	Mean ±*SD*
Acquiring Knowledge	above 25	24	47.791 ±5.183
	20-25	36	44.888 ±4.833
	15-20	52	45.038 ±7.911
	10-15	60	41.750 ±7.529
	Total	172	44.244 ±7.131
Applying Knowledge	above 25	24	21.916 ±3.855
	20-25	36	19.666 ±4.362
	15-20	52	22.019 ±5.396
	10-15	60	18.333 ±5.395
	Total	172	20.226 ±5.227
Reflection on knowledge	above 25	24	24.708 ±5.103
	20-25	36	25.944 ±2.946
	15-20	52	26.442 ±5.038
	10-15	60	21.733 ±6.519
	Total	172	24.453 ±5.638

From Table 5, teachers with experience more than 25 years got the highest mean for adopting the strategies for acquiring knowledge. Besides that, the majority of the science teachers with 10-15 years' experience use strategies for applying knowledge and reflection of knowledge constructs. In order to verify the significant differences between the means of the teachers regarding teaching strategy use, ANOVA analysis was used. Table 6 shows the results of this analysis.

Table 6
ANOVA Analysis for Science Teacher Strategy Use According to Years of Experience

Variable		Sum of Squares	df	Mean Square	*F*	Sig.
Acquiring Knowledge	Between Groups	723.057	3	241.019	5.079	.002
	Within Groups	7972.687	168	47.456		
	Total	8695.744	171			
Applying Knowledge	Between Groups	462.010	3	154.003	6.145	.001
	Within Groups	4210.147	168	25.060		
	Total	4672.157	171			
Reflection on Knowledge	Between Groups	731.220	3	243.740	8.702	.000
	Within Groups	4705.407	168	28.008		
	Total	5436.628	171			

Results in Table 6 indicated that the *F* value for acquiring knowledge, applying knowledge and reflection on knowledge constructs were 5.07, 6.145, 8.702 respectively with (p < .05) indicated that there are significant differences among science teachers' strategies use with different years of experiences. In order to further explore this differences Tukey post hoc test was used as the equality of variance was assumed. Table 7 shows the results of Tukey test.

Table 7
Results of Tukey HSD^{a,b} test

Variables		N	Subset for alpha = .05	
			1	2
Acquiring Knowledge	above 25	24		47.7917
	20-25	36	44.8889	44.8889
	15-20	52	45.0385	45.0385
	10-15	60	41.7500	
	Sig.		.164	.260
Applying Knowledge	above 25	24		21.9167
	20-25	36	19.6667	19.6667
	15-20	52		22.0192
	10-15	60	18.3333	
	Sig.		.164	.260
Reflection on Knowledge	above 25	24	24.7083	24.7083
	20-25	36		25.9444

15-20	52		26.4423
10-15	60		21.7333
Sig.		.072	.484

Results in table 7 revealed that the science teachers with 25 years of experience and more were found in subset 2. However, the strategies used for acquiring knowledge construct among science teachers with various years of experience was not significant (p > .05). In addition, the results showed that science teachers with 15-20 years of experience were more employing strategies for applying knowledge and reflection on knowledge constructs.

DISCUSSION

Based on the recent literature, teaching strategies play a vital role in enhancing students' acquisition of HOTS (Constantinou & Kuys, 2013; Karami et al., 2012; Yao, 2012). Therefore, this study is conducted to investigate the strategies used by science teachers to teach their students higher order thinking skills in science. In the context of higher order thinking, many in-service programs aimed at enhancing teaching capabilities and expanding teachers' repertoire of instructional strategies by emphasizing the connections between theory and practice (Miri et al., 2007). Therefore, creating the connections between educational theories and practice in the classroom is further necessary (Lunetta, Hofstein, & Clough, 2007). Hence, it is important to investigate to what extent science teachers incorporate advanced instructional strategies into their teaching in order to encourage students to use their higher cognitive skills in science. Examination of 7th grade science teachers' strategies use for the promoting students' HOTS was the main aim of the current study. The data collected on 7th grade science teacher strategies use indicated that the most popular strategies among 7th grade science teachers were strategies for acquiring knowledge which focus more on memorizing basic concepts in science. Whereas the least used strategies by science teachers were strategies for applying knowledge such as problem solving and hands-on activity by using science laboratory, which are the strategies that improve students' higher cognitive skills. The findings of this study supported Miri et al. (2007) who highlighted that for promoting students' HOT the male science teachers focused more on strategies for applying knowledge while female science teachers focused more on employing the strategies for reflection on knowledge. Findings of this study are consistent with Tatar, Yildiz, Buldur, and Akpinar (2012) and Hamzeh (2014). Moreover, the findings indicated that most of the experienced science teachers, in contrast to new science teachers, focus on strategies for improving students' higher order thinking skills

CONCLUSION AND IMPLICATION

The results of this study indicated that a variety of higher cognitive skills teaching strategies are lacking among the teachers and that low processing strategies, such as focusing on student's memorizing of basic concepts are dominant among 7th grade students which improve students' knowledge and comprehension levels. While strategies such as problem solving, collaborative learning and inquiry strategies that encourage students to use higher cognitive skills focusing on exploration, reflection and idea sharing have been suggested in the literature, these are less used by the teachers.

Hence, these results contribute to the body of knowledge in investigating the strategies used by secondary science teachers in teaching science. This is demonstrated through assessment of strategies used by 7th grade science teachers in the Iraqi-Kurdistan region.

However, the findings of the study have important implications for teachers and curriculum designers in science education. First, the science teachers could get the benefit from the findings of the study in getting acquainted with the weakness of their teaching methods. This finding would further encourage teachers to make efforts to improve their teaching strategies through adopting various activities that encourage students to use their higher cognitive skills in science learning. Besides, a connection between class activities and increasing students' higher order thinking skills was recommended by Wenglinsky (2002). According to the teachers' responses to the strategies use questionnaire, the findings emphasized that supplemental guide activities and textbooks put more emphasis on remembering, gathering information and organizing skills than on evaluating and analyzing skills. He stressed the importance of cognitive engagement in making classroom activities effective. This is reflected in studies conducted by Ramirez and Ganaden (2010) as well as Zohar and Schwartzer (2005) who asserted that, to equip students with higher cognitive skills and make them competitive, educators need to teach cognitive strategies that help their students to think reflectively, solve problems and make decisions.

Additionally, alternative assessment methods are very useful to prevent students from rote learning. For example, problem dealing in class with real-world cases; encouraging open-ended class discussions, and fostering inquiry-oriented experiments would increase students' higher order thinking skills (Krajcik & Mamlok-Naaman, 2006). Second, instructional designers could use the findings of this study to distinguish to what extent the science teachers are utilizing the activities that encourage students to use their higher cognitive skills. As a solution, the Ministry of Education could hold specialized courses for science teachers and encourage them to use the different teaching strategies, especially the cognitive strategies.

Based on the study results, it is recommended that further attention be given to the context of programs that comprise higher order thinking to increase the level of acquisition of higher cognitive skills in science learning, especially through in-service professional development programs for science teachers. Teachers can be trained on how to use the science curriculum by giving students the opportunity to understand the scientific concepts and apply them to daily life situations.

REFERENCES

Aktamis, H., & Yenice, N. (2010). Determination of the science process skills and critical thinking skill levels. In H. Uzunboylu (Ed.), *Innovation and creativity in Education* (Vol. 2, pp. 3282-3288).

Albaaly, I. (2012). The effectiveness of using Cyclic Inquiry Model (CIM) in developing some of science processes and the achievement in Science. *Journal of Educational Research, 31(*26), 259-283.

Avargil, S., Herscovitz, O., & Dori, Y. J. (2012). Teaching thinking skills in context-based learning: Teachers' challenges and assessment knowledge. *Journal of Science Education and Technology, 21*(2), 207-225. doi: 10.1007/s10956-011-9302-7.

Bibergall, J. A. (1966). Learning By Discovery: Its relation to Science teaching. *Educational Review, 18*(3), 222-231. doi: 10.1080/0013191660180307.

Bilgin, I. (2006). The effects of hands-on activities incorporating a cooperative learning approach on Eighth Grade Students' science process skills and attitudes toward Science. *Journal of Baltic Science Education, 1*(9), 27-37.

Bushman, B. B., & Peacock, G. G. (2010). Does teaching problem-solving skills matter? An evaluation of problem-solving skills training for the treatment of social and behavioral problems in children. *Child & Family Behavior Therapy, 32*(2), 103-124. doi: 10.1080/07317101003776449.

Bülent, A., Mehmet, E., & Nuran, E. (2014). The investigation of science process skills of elementary school teachers in terms of some variables. *Asia-Pacific Forum on Science Learning and Teaching, 15 (*1), 1-28.

Chapman, J. D., & Aspin, D. N. (2013). A Problem-Solving Approach to Addressing Current Global Challenges in Education. *British Journal of Educational Studies, 61*(1), 49-62. doi: 10.1080/00071005.2012.756166.

Chin, C., & Brown, D. E. (2002). Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education, 24*(5), 521-549.

Christmann, A., & Van Aelst, S. (2006). Robust estimation of Cronbach's alpha. *Journal of Multivariate Analysis, 97*(7), 1660-1674.

Constantinou, M., & Kuys, S. S. (2013). Physiotherapy students find guided journals useful to develop reflective thinking and practice during their first clinical placement: a qualitative study. *Physiotherapy, 99*(1), 49-55. doi: 10.1016/j.physio.2011.12.002

Davidson, N., & Worsham, T. (1992). *Enhancing thinking through Cooperative Learning.* New York, NY: Teachers College Press.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educational process*. Lexington, MA: Heath.

Dogru-Atay, P., & Tekkaya, C. (2008). Promoting students' learning in genetics with the learning cycle. *The Journal of Experimental Education, 76*(3), 259-280.

Gillies, R. M., Nichols, K., Burgh, G., & Haynes, M. (2014). Primary students' scientific reasoning and discourse during cooperative inquiry-based Science activities. *International Journal of Educational Research, 63,* 127-140. doi: http://dx.doi.org/10.1016/j.ijer.2013.01.001.

Hamzeh, M. A. H. (2014). Teaching strategies used by Mathematics teachers in the Jordan public schools and their relationship with some variables. *American Journal of Educational Research*, *2*(6), 331-340.

Harter, S. P. (2007). Scientific inquiry: A model for online searching. *Journal of the American Society for Information Science, 35*(2)*,* 110-117.

Hmelo, C. E., & Ferrari, M. (1997). The Problem-Based Learning tutorial: Cultivating Higher Order Thinking Skills. *Journal for the Education of the Gifted, 20*(4)*,* 401-422.

Johnson, W. G. (2008). Robert Gagne's educational theory and bibliographic instruction. *Community & Junior College Libraries, 14*(3)*,* 211-222.

Karami, M., Pakmehr, H., & Aghili, A. (2012). Another view to importance of teaching methods in curriculum: Collaborative learning and students' critical thinking disposition. *Procedia - Social and Behavioral Sciences, 46 ,* 3266-3270. doi: http://dx.doi.org/10.1016/j.sbspro.2012.06.048.

Krajcik, J., & Mamlok-Naaman, R. (2006). Using driving questions to motivate and sustain student interest in learning science. *Teaching and learning science: An encyclopedia* (pp. 317-327). Westport, CT: Greenwood Press.

Lati, W., Supasorn, S., & Promarak, V. (2012a). Enhancement of learning achievement and integrated science process skills using science inquiry learning activities of chemical reaction rates. In G. A. Baskan, F. Ozdamli, S. Kanbul, & D. Ozcan (Eds.), *4th World Conference on Educational Sciences* (Vol. 46, pp. 4471-4475).

Lawson, A. E. (1995). *Science teaching and the development of thinking*. Belmont, CA: Wadsworth.

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2007). Learning and teaching in the school science laboratory: An analysis of research, theory, and practice. In *Handbook of research on science education* (pp. 393-441). New York, NY: Routledge.

Marshall, J. C., & Horton, R. M. (2011). The Relationship of Teacher-Facilitated, Inquiry-Based Instruction to Student Higher-Order Thinking. *School Science and Mathematics, 111*(3)*,* 93-101.

Miri, B., David, B.-C., & Uri, Z. (2007). Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking. *Research in Science Education, 37*(4)*,* 353-369.

Newmann, F. M. (1990). Higher order thinking in teaching social studies: A rationale for the assessment of classroom thoughtfulness. *Journal of Curriculum Studies, 22*(1)*,* 41-56.

Norman, G. (2009). Problem-solving skills, solving problems and problem-based learning. *Medical Education, 22*(4)*,* 279-286.

Ozgelen, S. (2012). Students' Science process skills within a cognitive domain framework. *Eurasia Journal of Mathematics, Science & Technology Education, 8*(4), 283-292.

Panasan, M., & Nuangchalerm, P. (2010). Learning outcomes of project-based and inquiry-based learning activities. *Online Submission, 6*(2), 252-255.

Phan, H. P. (2009). Exploring Students' Reflective Thinking Practice, Deep Processing Strategies, Effort, and Achievement Goal Orientations. *Educational Psychology, 29*(3), 297-313. doi: 10.1080/01443410902877988.

Qin, X. H. (2011). The Application of Problem-Solving Method in Classroom Teaching. *Proceedings of the Fourth International Symposium on Education Management and Knowledge Innovation Engineering, Vols 1 and 2*.

Ramirez, R. P. B., & Ganaden, M. S. (2010). Creative activities and students' Higher Order Thinking Skills. *Education Quarterly, 66*(1).

Rotgans, J. I., & Schmidt, H. G. (2011). The role of teachers in facilitating situational interest in an active-learning classroom. *Teaching and teacher Education, 27*(1), 37-42.

Şimşek, P., & Kabapınar, F. (2010). The effects of inquiry-based learning on elementary students' conceptual understanding of matter, scientific process skills and science attitudes. *Procedia-Social and Behavioral Sciences, 2*(2), 1190-1194.

Singer, F. M., & Moscovici, H. (2008). Teaching and learning cycles in a constructivist approach to instruction. *Teaching and teacher Education, 24*(6), 1613-1634.

Taasoobshirazi, G., & Farley, J. (2013). A multivariate model of Physics problem solving. *Learning and Individual Differences, 24,* 53-62. doi: 10.1016/j.lindif.2012.05.001.

Tatar, E. (2011). The effect of guided inquiry and open inquiry methods on teacher candidates' science process skills. *Energy Education Science and Technology Part B-Social and Educational Studies, 3*(4), 669-680.

Thitima, G., & Sumalee, C. (2012). Scientific Thinking of the Learners Learning with the Knowledge Construction Model Enhancing Scientific Thinking. *Procedia - Social and Behavioral Sciences, 46*(0), 3771-3775. doi: http://dx.doi.org/10.1016/j.sbspro.2012.06.144.

UNESCO. (2011). World Data On Education (7th ed.). Retrieved from www.ibe.unesco.org/fileadmin/user_upload/.../pdf.../Viet_Nam.pdf

Vernez, G., Culbertson, S., & Constant, L. (2014). Strategic Priorities for Improving Access to Quality Education in the Kurdistan Region-Iraq. Santa Monica, CA: RAND Corporation. Retrieved from http://www.rand.org/pubs/monographs/MG1140z2-1.

Voica, C., & Singer, F. M. (2011). Using small scale projects as tools for changing the teaching paradigm. *Procedia-Social and Behavioral Sciences, 11*, 200-204.

Wenglinsky, H. (2002). How Schools Matter: The link between teacher classroom practices and student academic performance. *Education Policy Analysis Archives, 10 (*12), 1-30.

Williams, B., Brown, T., & Onsman, A. (2012). Exploratory factor analysis: A five-step guide for novices. *Australasian Journal of Paramedicine, 8*(3), 1-13.

Yao, K. J. (2012). Using Modern Educational Technology Promote Learners' Higher-Order Thinking Skill. In Z. Zhang & T. B. Zhang (Eds.), *2012 Third International Conference on Education and Sports Education* (Vol. 5, pp. 455-458).

Zachariades, T., Christou, C., & Pitta-Pantazi, D. (2013). Reflective, systemic and analytic thinking in real numbers. *Educational Studies in Mathematics, 82*(1)*,* 5-22. doi: 10.1007/s10649-012-9413-y.

Zawilinski, L. (2009). HOT blogging: A framework for blogging to promote Higher Order Thinking. *Reading Teacher, 62*(8)*,* 650-661. doi: 10.1598/rt.62.8.3.

Zohar, A., & Schwartzer, N. (2005). Assessing teachers' pedagogical knowledge in the context of teaching higher-order thinking. *International Journal of Science Education, 27*(13)*,* 1595-1620.

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