The Implementation of the Japanese Conceptual Lessons for Promoting the Egyptian Primary Students' Engagement in Science Learning

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Abstract:

This research examine and discusses the impact of the recently introduced Japanese conceptual lessons (Hypotheses and Experiments Lessons "HEL") on primary education in Egypt. The researcher conducted a comparison between the traditional science lessons and the Japanese conceptual lessons in science classes in urban and remote regions of Egypt in three grades of primary school. Students' observation cards, questionnaires, students' enjoyment of science and self-efficacy as aspects of students' engagement in science learning, were analysed. The study identified differences between primary school students' level of engagement in science learning in urban and remote regions as urban region had better result, and highlighted the promising impact of the Japanese conceptual lessons as a new teaching approach, comparing to the traditional method, aiming to promote primary students' engagement in science learning in its both dimensions' enjoyment of science and self-efficacy in primary schools.

Keywords: Engagement in Science Learning, self-efficacy, Enjoyment of Science, Japanese Conceptual Lessons, primary education, Urban and Remote Regions.

Introduction

Egypt Ministry of Education (MOE) has had great interest in Japanese education quality and system for the fact that Japan is one of the four highest countries in students' performance and engagement in science, and motivation towards science (OECD, 2018), and is one of the top five countries in the international science achievement at fourth and eighth grades (TIMSS, 2015). Because of this, there has been a longstanding cooperation between Egypt and Japan in the area of the educational reform since 1997 (JICA, 2016). MOE has shared several educational projects with the Japanese government (represented by Japan International Cooperation Agency "JICA") aimed to improve primary education in Egypt. In the first educational project from 1997 to 2000, (The Development of Creative Science and Mathematics Lessons in Primary Education), the Japanese conceptual lessons (HEL) were introduced for the first time in Egypt within a formal science teachers' guidebook (MOE, 2000), and through the formal teacher training programs. A group of primary science teachers was trained on these lessons during the effective teaching strategies training programs which held by (MOE) in cooperation of (PPMU) in urban and remote regions of Egypt. In the second project carried out from 2003 to 2006, teacher guidebooks were revised to be focused on the children-centered lesson (MOE, 2006), and the guidebook was integrated into the MOE's teacher training plan. Since 2016, new cooperation in the area of education has been established including early childhood, basic, technical and higher education, as well as scientific research, technology and innovation (the Egypt-Japan Education Partnership). This partnership aims to introduce Japanese-style education into Egypt including primary stage activities and class management.

The promising impact of the HEL as a teaching approach aiming to promote primary students' enjoyment of science and self-efficacy need to be studied. The set of lesson management system and lesson sheets provide a technical hint in designing effective method for science lessons to enhance conceptual learning and enjoyable study that encourages ongoing relations between students (Tanaka, 2004). A number of previous research were conducted to measure the impact of teacher training programs of the (HEL) on teacher's motivations and ability to apply the lessons' procedures in Egypt; but its impact on primary students' learning and enjoyment of science still is the question, and need more research; as no research was conducted yet on this issue.

The enhancement of science learning in the primary stage is the critical key issue of Egypt science education's reform program in the 21st century. Expanding science program quality of primary stage needs to make learner acquire knowledge, life skills, and values which are needed for knowledge society (World Education Forum, 2015). Thus, Egypt's rank in TIMSS science achievement were less than the international mean score, and the TIMSS scale center point of Egypt decreased gradually which it was (421) in 2003, and became (391) in 2007 and (371) in 2015 (TIMSS, 2003; National Center for Education Statistics, 2007; TIMSS & PIRLS International Study Center, 2015). The level of science education quality in Egypt of (2013-2014) was (2.0) and ranked at 145 out 148 countries, and Egypt occupied the last rank between all countries in quality of primary education with a score of (2.2) (Klaus, 2013).

Science education quality in urban regions still very law comparatively, and this problem increases in rural and remote regions of Egypt for serious reasons. On one hand, regardless of the external reasons belongs to the economics, social, and political context (MOE, 2014). The factors shape the educational system, school quality, and literacy policies stand behind education quality issues in Egypt, (Elbadawy, 2014; UNESCO, 2005) such as centralized educational system, insufficient financial balance, and slowing curriculum development process; these factors are too much severing and affected directly to science education quality.

On the other hands, there are other factors in general stand behind science education quality level, these reasons connected to the shortage of equipment and materials for science learning, insufficient teacher professional development for applying effective teaching materials and producing enjoyable lesson plans, and to the pressure of paper-test and scoring evaluation system (MOE, 2014, 37).

The primary students' level of involvement in science learning is connected directly to certain reasons, the most effective reason is the lack of applying effective teaching approaches in science classes, and the weak transferability of teacher training impact into science classrooms (MOE, 2008; MOE, 2014, 39). The availability and effectiveness of the educational process depend on the efficiency of science teachers (UNESCO, 2008). In Egypt, the untrained science teachers still apply the traditional method in most urban and remote regions schools. However, some teachers in urban regions trained on applying the effective teaching strategies and methods. They got the chance of training through the “International Partnership Projects”; or through the training courses introduced by the “Professional Academy for Teacher” (Professional Academy for Teacher, 2017); or through the training courses of the “Teachers First Program” (Teachers first Program, 2016). The problem become clearer in the remote regions of Egypt because of the insufficient training courses, and teachers’ low technology abilities and weakness of ICT skills. Besides, shortage of science materials and equipment, and the absence of the internet lines at primary schools (Arab League Educational, Cultural, and Scientific Organization, 2013).

Untrained teachers are deployed in basic schools in many developing countries as a measure to address enrolment escalation (Tanaka, 2012). The insufficient teacher professional development in Egypt is the key factor of decreasing outcomes of science learning in the primary stage (MOE, 2014, p.39).

The decline in students’ interest and achievement in science appeared in the result of the national standardized test (SAT) (National Center for Educational Evaluation and Examination, 2010) the apprehension level of the sample of schools was less than 50% in science, the different between governorate and even within each governorate was huge in both urban, rural, and remote regions, and the performance of lower Egypt regions was better than upper Egypt regions (MOE, 2014, p.41).

Statement of the Problem

The insufficient level of primary students’ performance and engagement in science learning, and the different between students' level of achievement and motivation of science learning in urban and remote regions of Egypt, the lack of applying the new teaching strategies that primary science teachers were trained on such as (HEL) due to dominant of the centralized traditional methods.

Research Questions

The following questions addressed in this research:

1. How does primary students' engagement in science learning of different educational grades differ between the Japanese conceptual lessons and the traditional science lessons in urban and remote regions of Egypt?
2. What impacts are associated with the application of the Japanese conceptual lessons on science primary students in urban and remotes regions of Egypt?

Literature Review and Previous Studies

In this section will introduce the background of the following: **1-**The origin and characteristics of the Japanese conceptual lessons (HEL); **2-** The engagement in science learning aspects of the enjoyment of science, and the self-efficacy.

The Japanese Conceptual Lessons:

The Japanese conceptual lessons were created by "Itakura Kiyonobu", and were first appeared in his research paper of conceptual learning in 1963. The lessons were known in Japan as "*Kasetsu Jikken Jugy*ou" (Hypotheses and Experiments lessons "HEL"). The first model lesson plan was designed for primary kinetics titled (A pendulum and swing) followed by several model lesson plans up to the present time (Itakura, 1963a, 1963b).

Itakura (1969) described his theory about science and the scientific method in 1969 in his book titled (Science and Method of Science). The theory defines that all the actions of a human to verify his/her hypothesis mean the (experiments) in science. This definition not only expands the concept of experimenting into all human life but also introduces the same concept of the experiment as in scientific inquiry into science class (Itakura, 1969). The first book that explained the procedures and method of (HEL) were produced in 1977 titled (A B C of Hypotheses and Experiments' Lessons) (Itakura, 1977, 1997).

The core idea of the Hypotheses and Experiments' Lessons (Tanaka & Ghanem, 2006) is to perform exciting and attractive lessons by means of introducing experiments and observation process for teaching scientific facts and concepts in science class. The terminology of (Hypotheses and Experiments Lessons “HEL”) clearly shows that it aims to compromise the educational experiments with the scientific ones.

Itakura, established a teacher society in Japan in 1970 called (Kasetsu Society) which means (the Hypotheses and Experiments Lessons Society). The society had designed and examined many lessons plans and materials through practical applications for many subjects. It considered one of the most active private educational organizations in Japan. Moreover, the active publisher company called (Kasetsu-shya) had provided many series of practical records of lessons in Japanese for conceptual learning for many subjects. They seek in the present days to translate their lessons into English and to publish them internationally under the following name: *(Hypothesis-Verification-Through-Experimentation Learning System)* (Kobayashi, 2009).

Characteristics of the Hypotheses and Experiments Lessons:

Depending on Itakura's research on the developmental history of the Copernican theory from the Ptolemaic theory in astronomy, he insisted, “scientific recognition is established only through the experiments as the subjective actions to nature itself”. He tried to introduce the main science process skills in researching to have a hypothesis and experimenting into the process of scientific study by students. The primary theory of the Hypotheses and Experiments lessons can be recognized in the following three principals: It aims to teach the most basic scientific concepts and laws, only the experiments that are the positive and subjective actions inquiring into nature can formulate a scientific concept or recognition in our mind, and a scientific recognition is a social recognition that is agreed, applied and valued in our human society (Itakura, 1969).

However; there are many methods that apply the scientific method in education such as problem solving, discovery, inquiry methods. The hypotheses and experiments lessons have a systematic procedure of lesson management and a special tool to perform an appropriate lesson. According to the procedure of lesson (Itakura, 1997), the teacher can guide students to think, to discuss, to observe experiments and finally to recognize the aimed scientific concept or law using the original (lesson sheet) as a printed lesson scenario. The main conceptual question written in the (lesson sheet) requires all the students to have their own hypothesis. And each hypothesis can be varied by hands-on experiments demonstrated by the teacher.

The conceptual lessons plans of the hypotheses and experiments lessons have to satisfy three primary criteria as follows: **1-** More than a half of the classroom students welcome the performed lesson according to the plan; **2-** Nearly all the students understand the contents and the objectives of the performed lesson according to the plan; **3-** The teacher who applied the lessons plan wants to perform the same lesson in another class (Tanaka & Tafida, 2006).

The lessons sheets are composed of the following main components (Itakura, 1997): A problem: conceptual question with answer choices; a research problem: optional questions with answer choices; training problem: question for further training; simple questions without answer choices; new scientific terms; scientific law and theory; scientific story; and documents and references.

The hypotheses and experiments lessons have **a systematic method of managing classes as follows**: **1-** Teacher distributes lesson sheets to all students one sheet by one. **2-**The students read the content of the first sheet. The teacher explains the content if necessary. **3-** Each student should select only one answer from several answer choices for the first question. **4-**The teacher asks the reasons why the students select their own answer. **5-** The students discuss the different reasons and the teacher manages their discussion. **6-** The teacher makes the experiment. **7-** The students observe it. 8-Move to the next question and experiment (Itakura, 1997).

Engagement in science learning:

Grabau and Ma (2017) explored nine aspects of science engagement using data from the 2006 Program for International Student Assessment (PISA). **The nine aspects are as follows:** science self-efficacy, science self-concept, enjoyment of science, general interest in learning science, instrumental motivation for science, future-oriented science motivation, general value of science, personal value of science, and science-related activities; they also reported that hands-on activities were positively related to additional aspects of science engagement (Grabau & Ma, 2017).

The variation in students' reports result of engagement in science across science teaching and learning activities indicated that there is an association between students' motivation towards science, enjoyment of science, and future orientation towards science, and the frequency in which various teaching and learning activities take place in the classroom (Hampden & Bennett, 2013).

Self- efficacy:

Self-efficacy is concerned with people’s beliefs in their capabilities to produce given attainments (Bandura, 2006). The theory of self-efficacy states that “it is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses” (Bandura, 1986, p. 391).

Self-efficacy is also positively related to interest and engagement (Schunk & Pajares, 2009). The investigation of the contribution of the motivational beliefs (self-efficacy and task-value) and cognitive engagement to seventh-grade students' science achievement indicated positive and significant correlations among self-efficacy, task-value and cognitive engagement variables (Bircan & Sungur, 2016).

Self-efficacy is a significant predictor of both the level of motivation for a task and ultimately task performance (Bandura & Locke, 2003). The examination study of the classroom goal structure perceptions, engagement, and self-efficacy of the students in relation to students' science achievement, with study participants, included (744) seventh-grade students from (9) public schools in Turkey, The study found that students who perceive mastery goal structures tend to show higher levels of engagement and self-efficacy in science classes, and students who have high self-efficacy and who are behavioral, emotionally, and cognitively engaged are more successful in science classes (Uçar & Sungur, 2017).

People’s beliefs in their capabilities are developed in four ways: through mastery experiences, through social modeling, by social persuasion, and by their physical and emotional states (Bandura, 2012).

Enjoyment of science:

The research of introducing the joyful learning activities in the rural area of India using child-centered classroom strategies suggested that student learn independent with no pressure to learn with joy and happiness, and the result, primary students become collaborative and curious and wonder in the classroom (Sriprakash, 2009).

The primary students who preferred a deep learning approach in science class enjoyed answering science questions and used the internet for research purpose. Moreover, a deep learning approach to science lessons is related to the enjoyment of science lessons and the attitude of finding science lessons necessary (Ilkörücü Göçmençelebi, Özkan, & Bayram, 2012). Other research suggested that primary students prefer hands-on activities to achieve learning enjoyment during life science lessons (Sammet, Kutta & Dreesmann, 2015).

The exploration of responses to primary science outreach program in Canada, and its relation to enjoyment, interest, perceptions of role modeling, and future career choice. The study founded that, girls and students from low-achieving schools found the program more enjoyable, provide positive science role models, and get them excited about science (Shanahan, Pedretti, DeCoito & Baker, 2011).

Methodology

This study applied a quasi-experimental research approach with (2 × 2 × 3) variables design, which consisted of two groups (experimental and control) of two regions of Egypt (urban and remote) and in three grades (fourth, fifth, and six) of primary school students (see table 1).

Table 1. Method and Design.

Region	**Grades**		
	Forth grade	**Fifth Grade**	**Six grade**
Urban Areas	**Control**		**Experimental**
Remote area	**Control**		**Experimental**

The effect of the independent variables (the Japanese conceptual lessons, and the traditional method), were measured on the dependent variables (science self-efficacy, and enjoyment of science). It applied students' observation checklist, science self-efficacy questionnaire, and science enjoyment questionnaire on nonrandomized groups of primary students in urban and remote regions of Egypt in the academic year (2015/2016).

Participants:

The research group (see table 2) included 299 primary school students, consisting of 160 students of urban region of

Egypt divided into an experimental group (79) and a control group (81); and 139 students from a remote region of Egypt divided into the experimental group (74) and control group (65). The number of students in every grade is shown in table 2 for all groups.

Lessons consisting of different science content (physical, life, earth science lessons) of the primary science textbooks (Ministry of Education, 2015/2016) (see table 3) were observed. The control group was observed during science class taught using the method considered as 'traditional' in the Egyptian context while the experimental groups observed in both urban and remote regions of Egypt were taught by science primary teachers who were trained in using HEL in MOE's formal training courses. The teacher training was organized by Egypt Ministry of Education (MOE) in cooperation with PPMU, and JICA in 2003-2004, and in 2007-2008. The science primary teachers were chosen for their attitude and motivation towards (HEL) and their experience of using the approach in their lessons (see Tanaka & Ghanem, 2006) research result. In each school of the sample in urban and remote regions of Egypt, the science primary teachers applied a lesson plan of the Japanese conceptual lesson (HEL) and were prepared for the observation on the same area of general science that be taught in the primary science curriculum. The researcher observed the lessons and videotaped them to re-observe them in a different time, the science self-efficacy questionnaire and science enjoyment questionnaire were applied by the researcher after each class for both experimental and control groups.

Instruments:

This paper applied for students' observation checklist, science self-efficacy questionnaire, and science enjoyment questionnaire on primary school students in three schools of the urban region and three schools in the remote regions of Egypt (see table 3). The research instruments were designed, organized, and applied by the researcher for the research purpose.

Table 2: The research group and the number of students.

Groups		Region	Grades			Total
			Fourth grade	Fifth Grade	Six grade	
Experimental Group - The Japanese conceptual lessons *(HEL).*		Urban area.	28	24	27	79
		Remote area.	22	27	25	74
Control Group - The common science lesson *(traditional*).		Urban area.	26	26	29	81
		Remote area.	20	22	23	65
Total	Experimental: 153 Control: 146	Urban: 160 Remote: 139	96	99	104	299

Table 3. The observed lessons & urban and remote regions.

Grades	Region					
	Urban Area			Remote Area		
	Governorate	School	Lesson	Governorate	School	Lesson
Forth grade	Cairo	Elmostakbal Primary school	State of Matter	Matroh – Elhamam.	Elnahda Primary School.	Metals & Non-Metals
Fifth Grade	Suez	Helal Primary School	Solutions	El Wadi Elgedid - Dhakhla.	Cement New Primary School	Magnets
Six grade	Alexandria	Osama Ibn Zayd Primary School	Moon Eclipse	Aswan – Kima.	Kima New Primary School	Heat Energy

Students' observation checklist:

The primary students' observation checklist (see appendix 1) aimed to observe primary students from grades (fourth, fifth, and sixth) in three classes for the control group, and in three classes for the experimental group in each region (urban and remote), and videotaped to re-observation process after two weeks of applications. It compared primary students' science practices during the common science lessons and during the hypotheses and experiments science lessons. The lessons subjects were similar in both groups for each grade (see table 3) but differ in the method of teaching. The students were rated during observation on four scales (4 = strong, 3 = average, 2 = weak, 1 = rare). The validity of the observation checklist was measured by a panel of jury, and was modified to be consisted of sixteen items in its final version. The reliability measured by cooper equation between first and second observation and was 92% indicating that the observation checklist is highly reliable. The researcher determine what performances students should master in science class to show their science self-efficacy. Thus, the construction of valid self-efficacy scales requires sound conceptual specification of the determinants governing performance in a given domain of functioning and the impediments to realizing desired attainments (Bandura, 2006).

Self-efficacy questionnaire:

The self-efficacy questionnaire (see appendix 2). The students were rated on a 5-point Likert scale (can do very well = 5, can do = 4, moderately can do = 3, can't do = 2, can't do at all = 1). The construction of the self-efficacy questionnaire based on Bandura's literature (Bandura, 1986; 1997; 2006; 2012; Bandura & Locke, 2003). The validity of the self-efficacy questionnaire measured by a panel of jury, and modified to twenty-two items in its final version. The reliability measured by the correlation coefficient of "Kuder Richardson" and amounted (0.88) which is reliable.

Enjoyment of science questionnaire:

The enjoyment of science questionnaire (see appendix 3). The students were rated on a 5-point Likert scale (strongly agree = 5, agree = 4, uncertain = 3, disagree = 2, strongly disagree = 1) for the positive sentences (1, 2, 5, 7, 9, 10, 13, 14, 16), and the opposite scale for the negative sentences (3, 4, 6, 8, 11, 12, 15). Primary students were asked how much they agreed with sixteen sentences designed to gauge their enjoyment of science. The validity of the enjoyment of science questionnaire measured by a panel of jury, and modified to sixteen items in its final version. The reliability measured by the "Cronbach Alpha" and amounted (0.85) which is reliable.

Data Analysis:

A three-way analysis of variance (ANOVA) (Gelman, 2005) was conducted to examine the variables, the differences were measured between the two groups (experimental, and control). Data were analyzed using SPSS software.

Result

Students' observation checklist result:

There were statistically significant differences at (0.05) level in the mean of the total degree of the students' observation card (see table 4) between the experimental group (153 students, M= 56.76), and the control group (146 students, M =28.45) favor to the experimental group (p = .000) with large effect size (η^2 = 0.892); and between urban region (160 students, M = 44.23) and remote region (139 students, M = 40.98) favor to the urban region (p = .000) with medium effect size (η^2 = 0.011); but there were no statistically significant differences between fourth grade (96 students, M =41.94), fifth grade (99 students, M= 41.90), and six grade (104 students, M = 43.97).

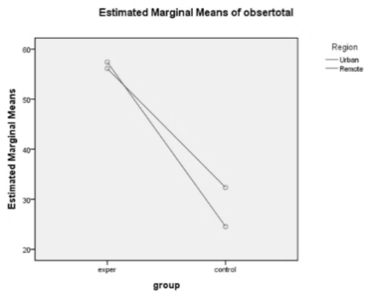
Students observation checklist interaction result:

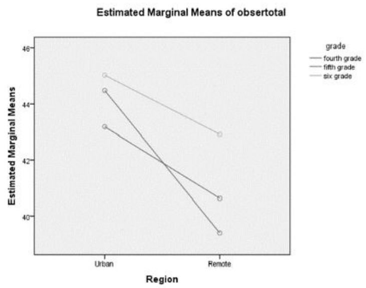
- The interaction between group and region was significant, it showed that the mean of the experimental group in urban (M = 56.11) and remote (M = 57.40) regions were close and were higher than the mean of the control group, but the mean of the control group in urban region (M = 32.35) was higher than the remote region (M =24.55) and both were lower than the experimental group, (see figure1).

Table 4. The univariate analysis of variance of the students' observation card.

Instrument	Source of variation	SS	df	MS	F-value	Sig. 0.05	Eta squared
Students' observation card.	group	59168.603	1	59168.603	2998.044	.000	0.892
	region	783.458	1	783.458	39.697	.000	0.011
	grade	283.416	2	141.708	7.180	.001	0.004
	group * region	1524.828	1	1524.828	77.262	.000	0.023
	group* grade	49.885	2	24.942	1.264	.284	-------
	region* grade	125.129	2	62.564	3.170	.043	0.001
	group*region*grade	134.772	2	67.386	3.414	.034	0.002
	error	5664.156	287	19.736			
	Total.	66262.301	298				

- The interaction between region and grade was significant, it showed that the mean of the six grade (M = 45.03) was highest then fourth grade (M = 44.48) then fifth grade (M= 43.18) in urban region, but in the remote region the mean of the six grade (M = 42.91) was highest then fifth grade (M = 40.63) then fourth grade (M = 39.39), and the mean of all grades in urban region was higher than the remote region, (see figure2).
- The interaction between group, region, and grade was significant, it showed that the mean of the experimental group in urban and remote region was close, and was higher than the control group in urban and remote regions, and the mean of the six grade was highest then fifth grade then fourth grade, the mean of the control group in urban region was better than the remote region, (see table 11) (see figure3). * There was no interaction between group and grades.





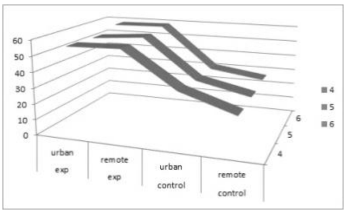


Figure 1. interaction between group and region Figure 2. interaction between region and grade. Figure 3. 3D shape for the interaction between group, region, and grade.

Self- efficacy questionnaire result:

There were statistically significant differences at (0.05) level in the mean of the total degree of the self-efficacy questionnaire (see table 5) between the

Table 5. The univariate analysis of variance of the students' self-efficacy questionnaire

Instrument	Source of variation	SS	df	MS	F-value	Sig.	Eta squared
Self-efficacy questionnaire.	group	188854.531	1	188854.531	6526.179	.000	0.949
	region	379.048	1	379.048	13.099	.000	0.001
	grade	159.146	2	79.573	2.750	.066	-------
	group * region	511.910	1	511.910	17.690	.000	6.522
	group* grade	129.753	2	64.876	2.242	.108	-------
	region* grade	311.916	2	155.958	5.389	.005	0.002
	group*region*grade	468.249	2	234.124	8.091	.000	0.041
	error	8305.205	287	28.938			
	Total.	198931.960	298				

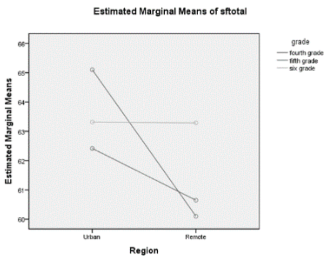
experimental group (153 students, m = 87.76), and the control group (146 students, M = 37.19) favor to the experimental group (*p* = .000) with large effect size (η^2 = 0.949); and between urban region (160 students, M =63.61) and remote region (139 students, M =61.34) favor to the urban region (*p* = .000); but there were no statistically significant differences between fourth grade (96 students, M =62.60), fifth grade (99 students, M = 61.53), and six grade (104 students, M = 63.30).

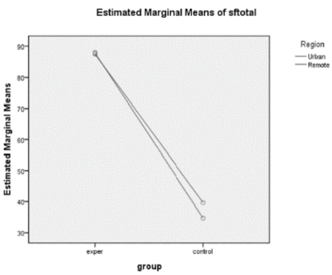
Self-efficacy questionnaire interaction result:

- The interaction between group and region was significant, it showed that the mean of the Exp. group in urban (M = 87.57) and remote (M = 87.94) regions were very close, and highest than the mean of the control group, but the mean of the control group in urban (M = 39.64) region was slightly higher than the remote region (M = 34.74), and both were lower than the Exp. group (see figure 4).
- The interaction between region and grade was significant, it showed that the mean of the fourth grade (M = 65.10) was highest then six grade (M = 63.31) then fifth grade (M= 62.41) in urban region, but in the remote region the mean of the six grade (M = 63.28) was highest then fifth

grade (M = 60.64) then fourth grade (M = 60.10), and the mean of fourth and fifth grades in urban region was higher than the remote region but was very close for the six grade in both regions (see figure 5).

- The interaction between group, region, and grade was significant. It showed that the mean of the experimental group in urban and remote region was close, and was higher than the control group, and the mean of the six grade was highest, then fifth grade, then fourth grade, the mean of the control group in urban region was better than the remote region (see table 11 & figure 6). *There was no interaction between group and grades.





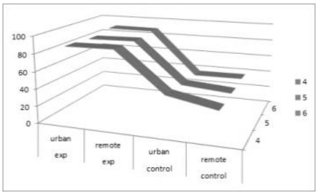


Figure 4. interaction between group and region. Figure 5. interaction between region and grade.
Figure 6. 3D shape for the interaction between group and region and grade.

Enjoyment of science questionnaire result:

There were statistically significant differences at (0.05) level in the mean of the total degree of the enjoyment of science questionnaire (see table 6) between the experimental group (153 students, M = 63.72), and the control group (146 students, M =26.94) favor to the experimental group (p = .000) with large effect size ($\eta^{٢}$ = 0.860); but there were no statistically significant differences between urban region (160 students, M =45.97) and remote region (139 students, M =44.69), or between fourth grade (96 students, M =45.50), fifth grade (99 students, M = 43.92), and six grade (104 students, M = 46.57).

Table 6. The univariate analysis of variance of the students' enjoyment of science questionnaire.

Instrument	Source of variation	SS	df	MS	F-value	Sig.	Eta squared
Enjoyment of science questionnaire.	group	99920.677	1	99920.677	1889.681	.000	0.860
	region	121.670	1	121.670	2.301	.130	------
	grade	356.455	2	178.228	3.371	.036	0.003
	group * region	69.723	1	69.723	1.319	252	-------
	group* grade	234.974	2	117.487	2.222	.110	-------
	region* grade	199.609	2	99.804	1.887	.153	-------
	group*region*grade	448.939	2	224.469	4.245	.015	0.003
	error	15175.698	287	52.877			
	Total.	116099.171	298				

Enjoyment of science questionnaire's interaction result:

- There was no interaction between group and region, between group and grades, and between region and grade.
- The interaction between group, region, and grade was significant. It showed that the mean of the experimental group in urban and remote region was close, and was higher than the control group, and the mean of the six grade was highest then fifth grade then fourth grade, the mean of the control group in urban region was better than the remote region (see table 11 & figure 7).

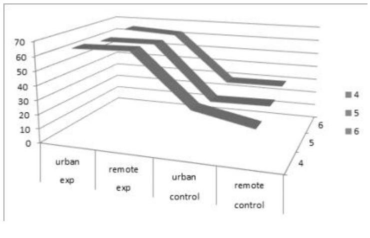


Figure 7. 3D shape for the interaction between group and region and grade.

Instruments' total degree result:

There were statistically significant differences at (0.05) level in the mean of the total degree of the instruments total value (see table 7) between the experimental group (153 students, M = 208.24), and the control group (146 students, M = 92.59) favor to the experimental group (p = .000) with large effect size ($\eta^{٢}$ = 0.942); and between urban region (160 students, M = 153.82) and remote region (139 students, M = 147.01) favor to the urban region (p = .000); but there were no statistically significant differences between fourth grade (96 students, M = 150.04), fifth grade (99 students, M = 147.36), and six grade (104 students, M = 153.84).

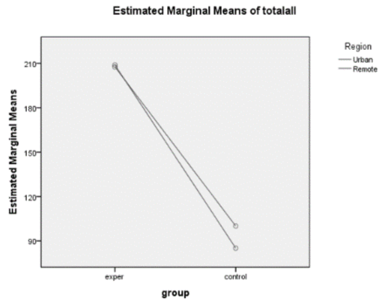
Table 7. The univariate analysis of variance of the total value.

Instrument	Source of variation	SS	df	MS	F-value	Sig.	Eta squared
Total.	group	987881.455	1	987881.455	5353.691	.000	0.942
	region	3421.065	1	3421.065	18.540	.000	0.003
	grade	2144.264	2	1072.132	5.810	.003	0.002
	group * region	4903.436	1	4903.436	26.574	.000	0.004
	group* grade	61.236	2	30.618	.166	.847	-----
	region* grade	1675.821	2	837.911	4.541	.011	0.001
	group*region*grade	2820.337	2	1410.168	7.642	.001	0.002
	error	52958.226	287	184.523			
	Total.	1048085.177	298				

Instruments total degree: interaction result:

- The interaction between group and region was significant, it showed that the mean of the experimental group in urban (M = 207.57) and remote (M = 208.91) regions were very close, and highest than the mean of the control group, but the mean of the control group in urban (M = 100.07) region was higher than the remote (M = 85.12) region, and both were lower than the experimental group (see figure 8).
- The interaction between region and grade was significant, it showed that the mean of the fourth grade (M = 156.84)

was highest then six grade (M = 155.36) then fifth grade (M = 149.26) in urban region, but in the remote region the mean of the six grade (M = 152.33) was highest then fifth grade (M = 145.46) then fourth grade (M = 143.25), and the mean of all grades in urban region were higher than the remote region (see figure 9). ** There was no interaction between group and grades or between the group, region, and grade.



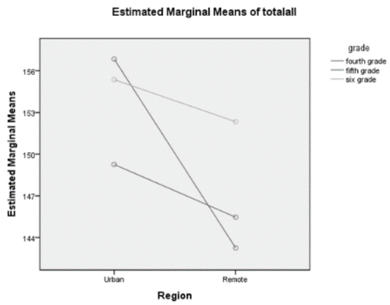


Figure 8. interaction between group and region. Figure 9. interaction between region and grade.

Comparison between groups:

There were statistically significant differences at (0.05) level in the mean of the total degree of all instruments (students' observation card, self-efficacy questionnaire, and enjoyment of science questionnaire) and its total degree between the experimental group (153 students), and the control group (146 students) favor to the experimental group (see table 8).

Table 8. Mean and standard deviation of the dependent variables according to groups.

Instrument	Groups	Mean (M)	Standard deviation (SD
Observation card.	Experimental	56.760	0.36
	Control	28.458	0.37
Self-efficacy questionnaire.	Experimental	87.760	0.43
	Control	37.196	0.44
Science enjoyment questionnaire.	Experimental	63.723	0.59
	Control	26.944	0.60
Total	Experimental	208.243	1.10
	Control	92.598	1.13

Comparison between regions:

There were no statistically significant differences at (0.05) level in the mean of the total degree of all instruments (students' observation card, self-efficacy questionnaire, and enjoyment of science questionnaire) and its total value of the

Table 9. Mean and standard deviation of the dependent variables according to regions.

Instrument	Group	Regions	Mean	Standard deviation (SD
Observation card.	Experimental	Urban	56.11	0.50
		Remote	57.40	0.51
	Control	Urban	32.35	0.49
		Remote	24.55	0.55
Self-efficacy questionnaire.	Experimental	Urban	87.57	0.60
		Remote	87.94	0.62
	Control	Urban	39.64	0.59
		Remote	34.74	0.66
Science enjoyment questionnaire.	Experimental	Urban	63.87	0.81
		Remote	63.56	0.84
	Control	Urban	28.07	0.80
		Remote	25.81	0.90
Total	Experimental	Urban	207.57	1.53
		Remote	208.91	1.58
	Control	Urban	100.07	1.51
		Remote	85.12	1.69

experimental group in the urban area (79 students), and the remote region (74 students); But there were statistically significant differences at (0.05) level of the control group in the urban region (81 students), and the remote region (65 students) favor to the urban region. In general, the experimental group's result was better than the control group in both regions (see table 9).

Comparison between grades:

There were no statistically significant differences at (0.05) level in the mean of the total degree of all instruments (students' observation card, self-efficacy questionnaire, and enjoyment of science questionnaire) and its total value of the fourth grade (96 students), fifth grade (99 students), and six grade (104 students), the mean values were close for all grades (see table 10).

Table 10. Mean and standard deviation of the dependent variables according to grades.

Instrument	grades	Mean	Standard deviation (SD
Observation card.	Fourth grade	41.941	0.45
	Fifth grade	41.909	0.44
	Six grade	43.977	0.43
Self-efficacy questionnaire.	Fourth grade	62.601	0.55
	Fifth grade	61.532	0.54
	Six grade	63.301	0.52
Science enjoyment questionnaire.	Fourth grade	45.507	0.74
	Fifth grade	43.923	0.73
	Six grade	46.571	0.71
Total	Fourth grade	150.049	1.39
	Fifth grade	147.364	1.37
	Six grade	153.849	1.33

The interaction between groups, regions, and grades:

The interaction between groups, regions, and grades was significant, it showed that the mean of the experimental group in both region was close, and was higher than the control group, and the mean of the six grade was highest then fifth grade then fourth grade, the mean of the control group in urban region was better than the remote region (see table 11).

Table 11. Mean and standard deviation of the dependent variables according to the interaction between group*region*grade.

Instrument	Groups	Regions	Mean and standard deviation			
			Total	Fourth grade	Fifth grade	Six grade
Observation card.	Experimental	Urban	56.11 (4.7)	55.29 (4.6)	54.68 (4.3)	58.38 (4.4)
		Remote	57.45 (4.7)	56.14 (5.6)	57.07 (4.1)	59.00 (4.3)
	Control	Urban	32.33 (3.8)	33.69 (3.3)	31.69 (4.1)	31.69 (3.8)
		Remote	24.69 (5.04)	22.65 (4.8)	24.19 (3.8)	26.83 (5.4)
Self-efficacy questionnaire.	Experimental	Urban	87.59 (4.1)	87.36 (3.9)	85.64 (4.4)	89.73 (3.1)
		Remote	87.91 (5.3)	88.00 (3.3)	86.63 (2.7)	89.20 (8.08)
	Control	Urban	39.54 (6.4)	42.85 (5.9)	39.19 (6.6)	36.90 (5.5)
		Remote	34.91 (6.3)	32.20 (5.9)	34.67 (4.7)	37.37 (7.1)
Science enjoyment questionnaire.	Experimental	Urban	63.91 (7.5)	64.39 (8.6)	62.36 (6.8)	64.88 (7.06)
		Remote	63.47 (8.1)	65.32 (7.1)	62.70 (7.8)	62.68 (9.3)
	Control	Urban	28.11 (6.8)	30.12 (5.4)	24.96 (5.8)	29.14 (7.8)
		Remote	26.05 (7.2)	22.20 (5.8)	25.67 (4.6)	29.58 (8.4)
Total	Experimental	Urban	207.62 (11.6)	207.04 (13.2)	202.68 (10.1)	213.00 (8.9)
		Remote	208.82 (13.9)	209.45 (11.3)	206.41 (9.4)	210.88 (19.2)
	Control	Urban	99.99 (14.1)	106.65 (12.7)	95.85 (13,9)	97.72 (13.7)
		Remote	85.65 (17.1)	77.05 (15.1)	84.52 (11.7)	93.79 (19.3)

Discussion and Implications

The primary students' level of engagement in science learning as shown after doing the previous comparisons between the traditional method and the newly introduced Japanese conceptual lessons (HEL), also between science classes in urban and remote regions of Egypt, and between three grades (fourth, fifth, and six) of primary stage; can be explained according to the following aspects:

1. The process of science teaching and its impact on primary school students differed between urban and remote regions for inequality of education circumstances and readiness between both regions, and for the sever problems which the remote regions of Egypt already have with lack of science materials and equipment, and with the insufficient professional development of science teachers. In such differentiation in level of education between urban and remote regions, the control group students' level of science learning in remote regions was less in quality than students in the urban regions when applying the traditional method, which is ineffective, because of concentrating on the cognitive dimension of learning ignoring conceptual learning, science process skills, and thinking abilities. The experimental group students in the remote regions, however all the existing problems could achieve a good level of science learning when applying the HEL as the same as the students in the urban regions.
2. The level of primary students of science self-efficacy and enjoyment of science learning promoted when the students passed through the experience of the HEL, and when they get rid of the traditional method limited efficiency. Thus, students of the experimental group have engaged deeply in science learning and constructed basic concepts meaningfully with certain signs of the following: the experimental students got curious about science lessons. They could ask and answer scientific questions, they discuss with teacher and other colleagues, they thought deeply in the alternative hypotheses, they verified the hypotheses, they observed and compared science experiments' result, they showed understanding of science knowledge, they cooperated and communicated during science classes, and achieved science objectives.
3. The primary school students in the three grades (fourth, fifth, six) showed promotion in their level of science self-efficacy and enjoyment of science learning when applying

the HEL, and their level of engagement in science was close in the three grades, but was less when applying the common science lesson and still close in mean value. This showed the power of the HEL to provide a good level of science learning at any grade of primary stage.

The Japanese conceptual lessons (HEL) had influenced students' manner of learning and transferred them from surface learning into deep learning by passing through effective teaching procedures, the primary students had the chances to think deeply and construct scientific concepts practically. The transition of students learning style affected directly science self-efficacy level, as there is a strong relationship between students learning style and promoting self-efficacy (Uçar & Sungur, 2017; Zheng, et al., 2018); and also increased their level of enjoyment of science learning (Ilkörücü, Özkan, & Bayram, 2012); moreover, It supported their cognitive engagement with highlighting their motivation to seek science achievement (Bircan, & Sungur, 2016); besides, the primary students promoted their science performances which escalated their level of science self-efficacy (Arslan, 2012).

The result of this research implies the potential power of applying the Japanese conceptual lessons (HEL) in primary science stage for the three grades and in different school level in urban and remote regions in Egypt. The HEL can raise students' interest in science, can promote students' self-efficacy of science practices, and increase their enjoyment of science which indicate more efficacy of engaging primary students in deep science learning, and performing a high level of science class with possible inexpensive simple teaching materials available for all level of schools in Egypt.

The result recommends focussing on promoting primary students' performance of science and engagement in deep science learning and to train science teachers to master the HEL, and to provide them with an effective guidebook to apply these effective science lessons all over Egypt.

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Notes:

1. Egypt Ministry of Education (MOE): http://www.moe.gov.eg/
2. ITAKURA, Kiyonobu (1930 - 2018): is an education scholar, He was born in Tokyo and graduated from the University of Tokyo. he worked for "the National Institute for Educational Research: and for "the National Institute for Educational Policy Research" of Japan from 1959 until 1995, chairman of "The History of Science Society" of Japan from 2013 until 2016; the head of the "Hypotheses and Experiments' Lesson Society" in Japan, he passed away in February 2018.
3. JICA: Japan International Cooperation Agency (JICA). https://www.jica.go.jp/english/
4. "Kasetsu-shya": Is the main publisher of "The Hypotheses and Experiments Lessons Society". Address: 2-13-7 Takadanobaba, Shinjuku-ku, Tokyo, Japan, 169. Tel: 0081-3-3204-1779, Fax: 0081-3-3204-1781.
5. "Kasetsu Society": *"The Hypotheses and Experiments Lessons Society"*: was founded in 1970 and its members are the Japanese school teachers and educational researchers. http://www.kasetu.co.jp/; https://www.facebook.com/kasetusya.
6. PPMU: Program Planning Monitoring Unit, Ministry of Education, Egypt; aided by the World Bank and the European Union.

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