

# **The Effectiveness of Learning Cycle Strategy (7E's) in Acquiring of Concepts Electrochemistry, Scientific Skills, and its Motivation toward Science among the Third-Secondary Grade Students in the Kingdom Saudi Arabia**

Mohammed Rahim Alotaibi

School of Educational Studies, Universiti Sains Malaysia, Saudi Ministry of Education

Nor Asniza Ishak

School of Educational Studies, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

Email: [asnizaishak@usm.my](mailto:asnizaishak@usm.my)

**DOI Link:** <http://dx.doi.org/10.6007/IJARBSS/v15-i7/26153>

**Published Date:** 31 July 2025

## **Abstract**

This study investigates the effectiveness of the 7E Learning Cycle Strategy in enhancing students' acquisition of electrochemistry concepts, development of scientific skills, and motivation toward learning science among third-grade secondary students in Saudi Arabia. Electrochemistry is known to present significant conceptual challenges for students due to its abstract nature and multi-level representations. Using a quasi-experimental design, the study compared the performance of students taught through the 7E Learning Cycle Strategy with those taught using traditional methods. A sample of 122 students (male and female) was selected from public secondary schools in Riyadh. Data collection tools included a concept acquisition test, a scientific skills test, and a motivation scale. Statistical analyses revealed that students in the experimental group significantly outperformed their peers in concept acquisition and scientific skills. Moreover, the strategy showed a positive impact on student motivation. Gender differences were also explored and discussed in light of Saudi Arabia's educational structure. The findings support the integration of the 7E Learning Cycle Strategy in chemistry instruction to foster deeper understanding, critical thinking, and active student engagement. The study provides practical implications for curriculum developers and science educators aiming to improve chemistry education in similar educational contexts.

**Keywords:** 7E Learning Cycle, Electrochemistry, Scientific Skills, Motivation, Chemistry Education

**Introduction**

Over the past two decades, global K–12 science education has shifted toward fostering deeper conceptual understanding, problem-solving ability, and scientific inquiry. Frameworks such as the Next Generation Science Standards (NGSS in the United States and recommendations from the OECD's PISA reports emphasize the need for students to actively engage in constructing knowledge, developing scientific reasoning, and applying concepts to real-world problems and skills-oriented approaches to teaching science (Morris, 2025). These shifts reflect a broader recognition that traditional lecture-based methods often fail to promote deep conceptual understanding or the development of critical scientific skills (Nicol et al., 2020; Musfiroh et al., 2024). It reflects a growing consensus that effective science education must move beyond rote memorization and promote scientific literacy, critical thinking, and real-world application of knowledge. Furthermore, teacher education programs frequently emphasize traditional instructional methods over the complex skills required to implement balanced and comprehensive inquiry science instruction effectively.

The learning cycle is one of the educational applications of the constructivist theory and the ideas of Jean Piaget, and teaching using the The Learning Cycle Strategy, (5E's) is better than the effect of traditional teaching models. The Learning Cycle Strategy (5E's) improves students' mastery of concepts. In addition, integrating chemistry activities with the learning cycle strategy may lead students to try to solve a chemistry learning problem using their scientific skills (Choirunnisa et al., 2018).

In alignment with these trends, the 7E's Learning Cycle model is well-aligned with grounded in constructivist theory. As a constructivist instructional framework, it encourages active student engagement, exploration of scientific phenomena, collaboration, and reflection. Each phase of the cycle—Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend—supports students in building their understanding while also developing scientific process skills and motivation. Research from various countries has demonstrated the model's effectiveness in improving science achievement, critical thinking, and engagement across diverse educational settings (Elia et al., 2024; Ali et al., 2024; Musfiroh et al., 2024). Research has also shown that the 7E's model enhances not only academic performance in science but also students' motivation, critical thinking, and process skills across various international contexts (Santi & Atun, 2021; Musfiroh et al., 2024). Thus, applying the 7E's Learning Cycle in the Saudi educational context is both timely and consistent with global reform efforts in science education.

Al-Zoubi (2017) affirms that teaching chemical concepts using strategies based on constructivism theory help students to acquire a correct understanding of chemistry and its writing skills, given the opportunities it provides for thinking about educational tasks and activities, opportunities for social cooperation and opportunities for what goes around in the structure. Mentality of the student.

From a policy perspective, although recent reforms under Saudi Vision 2030 aim to promote gender equity in education, disparities in professional development for male and female teachers and variations in curriculum delivery methods still persist. These differences may contribute to variations in how Learning Cycle Strategy (7E's's) in acquiring concepts of

Electrochemistry for third-grade secondary student electrochemistry is taught and understood across genders. Including these contextual insights allows the study to more effectively explore how cultural, pedagogical, and systemic factors interact with gender to shape student learning outcomes in electrochemistry.

### **Problem Statement**

Electrochemistry is a fundamental yet challenging topic in secondary chemistry education due to its complex theoretical concepts and practical applications. Students often face difficulties in distinguishing between galvanic and electrolytic cells, electric circuits, redox equations, and electrochemical cells, mastering electrolysis calculations, and relating electrochemical concepts to everyday phenomena such as corrosion and batteries (Ali et al., 2022; Tsaparlis, 2019). A mini-review by Ali et al. (2022) analyzed over 60 studies on high school students' learning difficulties in electrochemistry concepts (e.g., redox reactions, electron flow, electrode functions). It highlighted common misconceptions and proposed strategies to enhance teaching and learning in this area. The review identified more than fifty prevalent misconceptions related to key electrochemistry topics such as electrolytes, ions, oxidation-reduction reactions, electrolytic conduction, and electrochemical cells. Major challenges include students' difficulty in connecting core concepts with structure-property relationships, lack of instructional aids, misinterpretation of scientific language, cognitive overload, and trouble representing chemical phenomena across macroscopic, particulate, and symbolic levels. Additionally, misconceptions introduced by teachers and textbooks further hinder understanding.

Students face several challenges when learning electrochemistry. They often struggle to differentiate between the flow of electrons in metallic conductors and electrolytes. Many have difficulty identifying the anode and cathode, as well as distinguishing the positive and negative terminals of an electrochemical cell. Additionally, students frequently find it hard to explain the specific processes occurring at each electrode. Confusion between oxidation and reduction reactions is also common, further complicating their understanding. Another significant obstacle is their limited grasp of the concept of electrolytes and their role in electrochemical systems (Osman, & Lee, 2014 cited in Ali et al., 2022). These challenges contribute to weak scientific inquiry skills and low motivation toward science learning among secondary students. Addressing these specific difficulties through effective instructional strategies like the 7E's Learning Cycle is essential to improve students' conceptual understanding, scientific skills, and motivation.

In this context, the incorporation of the 7E's learning cycle model in the science curriculum including electrochemistry is necessary, so students can construct their knowledge themselves by actively participating in class and creating ideas to solve everyday problems (Noreen et al., 2024). The 7E's Learning Cycle strategy consisting of Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend phases offers a structured, constructivist approach that can effectively address these challenges. Each phase is designed to promote deep learning, active participation, and conceptual change (Noreen et al., 2024). By actively involving students in each phase, the 7E's model not only improves conceptual understanding and scientific skills but also fosters a more positive attitude and intrinsic motivation toward science learning. Its structured yet flexible framework makes it particularly suitable for addressing the multi-dimensional difficulties students face in electrochemistry.

The 7E's Learning Cycle strategy is highly effective in addressing students' difficulties in scientific skills and motivation. Research has shown that students often struggle with planning and conducting experiments, interpreting data, and applying scientific reasoning in practical tasks. The Explore and Evaluate stages of the 7E's model are designed to develop these competencies by immersing students in hands-on activities and guided inquiry, thereby enhancing their scientific process skills (Elia et al., 2024). Isaac et al. (2024) concluded that teaching with 7E's's learning cycle was more effective in enhancing secondary school students' achievement in science disciplines such as genetics than the lecture method. Furthermore, scientific skills are reinforced as students engage in observation, data collection, and critical analysis during learning cycles that mimic authentic scientific investigation (Musfiroh et al., 2024).

In terms of motivation, students frequently find science abstract and disconnected from their daily experiences. The Engage and Extend phases of the 7E's model play a critical role in improving intrinsic motivation by linking scientific concepts to real-life contexts and encouraging curiosity-driven exploration. Studies have reported significant improvements in students' academic motivation, achievement, retention, confidence, and engagement when taught using the 7E's model, particularly in science subjects like biology and chemistry (Abdullahi et al., 2021). This motivational impact is attributed to the learner-centered, inquiry-based nature of the model, which gives students greater autonomy and meaningful involvement in their own learning process.

Recent studies have also suggested that gender differences may influence students' science achievement and engagement, especially in chemistry-related topics (Gong et al., 2023). Omeje (2023) showed that secondary school male students who were taught electrochemical cells with project-based learning recorded higher academic achievement than their female counterparts. The study recommends incorporating project-based learning in chemistry instruction to enhance student performance. Saudi Arabia's education system is characterized by strict gender segregation, with boys and girls attending separate schools and being taught by same-gender teachers from primary through postgraduate levels (Alnahdi & Schwab, 2023). This structure creates distinct educational environments that may influence students' learning experiences and outcomes

Research indicates that gender segregation can impact students' academic achievement and engagement. For instance, a study by Alnahdi & Schwab, 2023 analyzing TIMSS 2019 data found that female teachers in Saudi Arabia often exhibit more positive attitudes toward teaching and employ more effective teaching practices, which are positively associated with students' achievement in mathematics and science. Additionally, gender differences in achievement have been observed, with girls outperforming boys in both mathematics and science at various grade levels. These findings suggest that the gendered structure of the education system may contribute to differences in educational experiences and outcomes. Therefore, examining gender as a variable allows for a more nuanced understanding of how educational practices and policies affect male and female students differently. In the such context, where boys and girls are educated separately, it is important to examine whether the 7E's Learning Cycle strategy is equally effective across genders. Therefore, this study aims to investigate not only the general effectiveness of the 7E's model but also whether male and

female students benefit equally from it in terms of concept acquisition, scientific skills development, and motivation toward science.

Therefore, this study aims to investigate the effectiveness of the Learning Cycle Strategy (7E's's) in improving the acquisition of electrochemistry concepts, the development of scientific skills, and the motivation to learn chemistry among third-grade secondary students in Saudi Arabia. Additionally, the study examines how these outcomes may vary by gender and teaching method, providing evidence to support more inclusive and effective instructional practices in chemistry education.

#### *Research Objectives*

1. Examining the effectiveness of teaching using the Learning Cycle Strategy (7E's's) in acquiring Electrochemistry concepts for third-grade secondary students in the Kingdom of Saudi Arabia.
2. Examining the effectiveness of using Learning Cycle Strategy (7E's's) in developing scientific skills for third-grade secondary students in the Kingdom of Saudi Arabia based on method of teaching (Learning Cycle Strategy (7E's's) , and Traditional method)), and gender (male and female).

#### *Research Questions*

Q1: What is the effectiveness of teaching using the Learning Cycle Strategy (7E's's) in acquiring concepts of Electrochemistry for third-grade secondary students in the Kingdom of Saudi Arabia based on method of teaching (Learning Cycle Strategy (7E's's) , and Traditional method)?

Q2: What is the effectiveness of using Learning Cycle Strategy (7E's's) in developing scientific skills for third-grade secondary students in the Kingdom of Saudi Arabia based on method of teaching (Learning Cycle Strategy (7E's's) , and Traditional method)), and gender (male and female)?

#### *Study Hypotheses*

H01 : There are no statistically significant differences at the significance level ( $p = 0.05$ ) between the mean scores of the grades of the third year of secondary students in the test of the acquisition of Electrochemistry concepts based on method of teaching (Learning Cycle Strategy (7E's's) , and traditional method).

H02 : There are no statistically significant differences at the significance level ( $p = 0.05$ ) between the mean scores of the grades of third-year secondary students in the science skills test based on method of teaching (Learning Cycle Strategy (7E's's), and traditional method, and gender (male and female).

#### **Significance of the Study**

This study can provide support for teachers who want to provide learning opportunities related to the real world that also engage students in learning through the use of the Learning Cycle Strategy (7E's's) in teaching students that contribute to increasing their acquisition of chemical concepts and increasing their motivation towards chemistry.

Currently, few studies have used the strategy of the Learning Cycle Strategy (7E's's) in Saudi Arabia for providing students with concepts of Electrochemistry, scientific and

motivational skills towards chemistry in the Kingdom of Saudi Arabia. This is expected to improve the students' academic performance.

The results of this study may be useful in directing educators' attention to the importance of using the strategy of Learning Cycle Strategy (7E's's) in science subjects, especially chemistry, and giving it more attention when developing science curricula and textbooks.

### **Operational Definitions**

#### *Learning Cycle Strategy (7E's's)*

An educational-learning strategy that includes seven sequenced and organized stages, which the teacher employs with students inside the classroom in order to build and expand students' knowledge of themselves (Tannous, 2014). For this study, it is defined as a teaching strategy that will be used in this study to clarify the concepts of Electrochemistry for third-graders, and it is based on seven sequential and organized stages: excitement, exploration, interpretation, expansion, extension, exchange, and evaluation.

#### *Acquiring Concepts of Electrochemistry*

It is the students' understanding of electrochemistry, which is one of the branches of chemistry. It deals with the study of chemical reactions that result in electrical energy and its applications in life, and it is prescribed for third year secondary students in the Kingdom of Saudi Arabia (Al Harbi, 2017). For this study, the student's understanding of the concepts of Electrochemistry from the book of chemistry for the third year of secondary for the academic year 2021/2022, which is approved by the Ministry of Education in the Kingdom of Saudi Arabia, and is measured by the score obtained by the student in the testing of concepts of Electrochemistry prepared specifically for this purpose

### **Limitations of the Study**

The study was limited to the electrochemistry unit of the teaching units in Chemistry 4 (courses system) in the natural sciences track in the Kingdom of Saudi Arabia. Therefore, the study will be limited to a sample of male and female third year secondary students studying chemistry 4 (courses system). The application of the study will be limited to the academic year 2023/2024.

The study will be limited to government schools affiliated to the city of Riyadh in the Kingdom of Saudi Arabia, which have students in the third scientific secondary grade and whose students study Chemistry 4 (The Course System).

The results of the study will be determined by the degree of validity and consistency of the test of the acquisition of concepts of Electrochemistry and the testing of scientific skills, and the motivation scale towards learning Chemistry prepared by the researcher, and the seriousness of students in answering test questions.

## Method

In this study, using the quantitative approach, the researcher will use the quasi-experimental designs.

### *Population and Sample*

The study Population consists of all students of the third year of secondary school in the Department of Education for the Riyadh city for the academic year 2022-2023, consisted of (3458) students according to the official records issued by the Education Department for the Riyadh city after taking the official approvals approved for this purpose.

### *Study Sample*

A representative sample of the study community will be chosen in the convenience sample, This study used convenience sampling (Creswell & Poth, 2018). Convenience sampling technique will be used to select a sample of the students. This sampling technique will be chosen because have collaboration schools where the researcher will teach in order to facilitate the data collection process. Merriam and Tisdell (2016) further discussed that participants in convenience sampling are chosen due to the researcher's location. to save time and effort on the researcher, as two controlling divisions and two experimental divisions will be chosen from the third-grade students in each school chosen, and the researcher will randomly assign to distribute students in the two groups: the control group and the experimental group. The following table shows an estimate of the sample.

Table 3.1

### *Estimation of the study sample*

Group	Gender	The Number
Experimental	Male	30
	Female	32
	Total	62
control	Male	30
	Female	30
	Total	60
Total	Male	60
	Female	62
	Total	122

## Study Instruments

### *Test for Electrochemistry*

The electrochemistry concepts acquisition test was constructed and designed to measure third-grade students' acquisition of chemical concepts in the electrochemistry unit from the chemistry textbook for the third grade of secondary school in the Kingdom of Saudi Arabia. By adopting the cognitive levels, The test, in its initial form, consisted of (25) multiple choice items.

### *Scientific Skills*

The test was prepared and designed to measure scientific skills, as it included the following skills: (Observation, Conclusion, Prediction, Classification, Use of Numbers, Interpretation of Data, Experimentation). The test, in its initial form, consisted of (25) multiple choice items, with four alternatives for each question. With the aim of measuring the degree

of acquisition of scientific skills by third-grade students in the Kingdom of Saudi Arabia in the electrochemistry unit in the chemistry textbook for the third grade of secondary school.

### *Validity*

The test presents five expert selected from Saudi Ministry of Education to determine the suitability of the test. The authors evaluated the detailed test and provided comprehensive feedback. The test was then slightly modified according to their feedback.

The experts expressed their opinion about the test prepared for this regard in terms of: the suitability of the test to measure what it was prepared for, the soundness and appropriateness of the linguistic formulation, the clarity of the question idea, the consistency of the alternatives, the clarity of the sufficiency of the instructions, and the validity of the alternative referred to as representing the correct answer, And classifying the question within Bloom's cognitive levels included in the questions (remember, apply, understand, higher). Where the questions were amended and formulated, which experts indicated the need to amend.

### *Reliability*

In the Kuder Richardson 20 (KR-20), the closer the coefficient value is to 1.0, the higher the reliability of the instrument. (Sekaran & Bougie, 2010). In this study, the test for electrochemistry calculated reliability coefficient for the KR-20 is 0.89 values are statistically significant at 0.05 level of significance.

### *Scientific Skills*

The consistency of the test will be confirmed by applying it to a sample consisting of (30) students from outside the target study sample and then re-applying it to the same sample and the same conditions after two weeks, and monitoring the responses of students to the test paragraphs and then calculating the stability of the test using the Richard Richardson formula (KR -20). Where the results of Kuder Richardson (KR-20) for the scientific skills test sample showed (0.87), which are statistically significant values at the level of significance ( $\alpha \geq 0.05$ ).

### **Data Collection**

To achieve the goals of the study and answer its questions, the researcher will follow the following procedures: Defining the study problem, its questions and its variables, and Viewing the theoretical literature and previous studies related to the subject of the study.

After the above, the researcher Preparing and building study instruments after reviewing theoretical literature and previous studies, Verifying the veracity of the study instruments. Then Obtaining an important facilitation letter from the university to facilitate the researcher's mission. And checking the stability of the study instruments.

Test Agreement with the principals of the study sample schools on the date for carrying out the study, after bringing the official letters from the Education Department. Applying the tribal chemical concepts acquisition test to the control and experimental study groups before starting the teaching process to know the extent of equivalence of the two groups, after clarifying the purpose of the study for the individuals of the sample, clarifying instructions for

answering the test paragraphs to obtain objective responses, and ensuring that the data will be used for scientific research purposes, it will be treated strictly confidential.

Teaching will start in accordance with the strategy of the Learning Cycle Strategy (7E's's), where the control group was taught in the traditional way, and the experimental group in the Learning Cycle Strategy (7E's's). The acquisition of Electro chemistry concepts and scientific skills test will be applied after the completion of teaching according to the strategy of the Learning Cycle Strategy (7E's's), and then the motivation scale will be applied to students.

Test papers will be collected from students, then emptied using the SPSS program, and for conducting appropriate statistical treatments. The results achieved will be discussed after statistically analyzing the data, and making recommendations in light of the results. Then The study summary will be written.

### *Study Variables*

First: Independent Variables:

Teaching strategy used and has two levels: (Learning Cycle Strategy (7E's's) and Traditional learning).

Gender has two levels: (Male, Female).

Second: Dependent Variables: This includes students' acquisition of concepts of Electro chemistry, scientific skills, and the motivation towards learning chemistry.

### *Data Analysis*

- To answer the first hypothesis, Arithmetic means and standard deviations will be used, and the Independent sample T-Test will be used to detect the effect of teaching.
- To answer the third hypothesis, the arithmetic mean and standard deviations will be used, as well as the binary variance analysis for the total score (2-Way ANOVA) and (Two-Way MANOVA) scientific skills.

## **Data Analysis and Discussion**

### *Research Question One and Discussion*

There are no statistically significant differences at the significance level ( $\alpha = 0.05$ ) between the Mean Score of the grades of the third year of secondary students in the test of the acquisition of Electrochemistry concepts base on method of teaching (Learning Cycle Strategy (7E's's) , and Traditional method).

For answering the first hypothesis, an independent-sample t-test was used. Table 4.4 shows the Means, standard deviations, and the results of an Independent- sample t-test for the differences between the mean scores of the third year secondary students in the test of acquiring electrochemistry concepts due to the teaching method in the pre and post-test of the experimental and control group scores, and the Table 4.4 and 4.5 shows that.

Table 1

*Means, Standard Deviation, and t-test results for pre-tests of the Experimental and Control Groups for method (7E's's)*

Concepts electrochemistry	GROUP	N	Mean	Std. Deviation	t	df	p
Galvanic cells	Experimental	62	3.87	0.80	1.858	120	.06
	Control	60	3.45	1.59			
Batteries	Experimental	62	2.21	1.22	1.118	120	.266
	Control	60	3.48	1.48			
Electrolysis	Experimental	62	2.11	0.95	1.553	120	.280
	Control	60	1.83	1.04			
Concepts All	Experimental	62	9.03	2.16	0.882	120	.279
	Control	60	8.62	2.99			

The results in Table showed that there were no significant statistically

Table 2

*Means, Standard Deviation, and t-test results for post-tests of the Experimental and Control Groups for method (7E's's)*

Concepts electrochemistry	GROUP	N	Mean	Std. Deviation	t	df	p
Galvanic cells	Experimental	62	7.97	1.98	6.521	120	.01
	Control	60	5.60	2.03			
Batteries	Experimental	62	6.05	1.63	7.213	120	.01
	Control	60	3.95	1.58			
Electrolysis	Experimental	62	2.89	0.98	4.113	120	.01
	Control	60	2.12	1.09			
Concepts All	Experimental	62	16.82	3.47	8.09	120	.01
	Control	60	11.93	3.20			

The results in Table 2 showed that there were significant statistically significant differences between the mean scores of the third grade secondary students in the test of electrochemistry concepts in the post-test for the scores of the control and experimental groups, where it was ( $p = .05$ ), which indicate the existence of a difference In the average grades of the third year secondary students in the test of acquiring electrochemistry concepts, it is attributed to the teaching method (Learning Cycle (7E's's), Traditional method) and in favor of the experimental group the strategy of Learning Cycle Strategy (7E's's).

Therefore, the null hypothesis is rejected. And accepting the alternative hypothesis, which states that "there are statistically significant differences between the mean scores of the grades of the third year of secondary students in the test of the acquisition of Electrochemistry concepts based on method of teaching (Learning Cycle Strategy (7E's's), and Traditional method). This means that the experimental group using the proposed Learning Cycle Strategy (7E's's) showed significantly better scores than the control group using the presently used traditional method.

This may be due to the fact that the Learning Cycle Strategy (7E's's) was suitable for learning the Electrochemistry concepts included in the electrical chemistry unit. Where the teaching steps according to this strategy allowed students an opportunity to think, by exploring and

discussing concepts and working to stimulate students' thinking by increasing their ambition to learn more, and this contributed to attracting their attention to the lesson and communicating with their colleagues and exchanging opinions on those concepts that have been established in the minds of students.

This result indicates that the Learning Cycle Strategy (7E's's) and the activities and interactions it includes, in which the student becomes active and the focus of the educational process, have provided greater opportunities for learning that depend on excitement and attracting the students' attention, which has been reflected in increasing the students' concentration.

This finding is consistent with the assertions of Al-Otaibi study (2023), which indicated the existence of statistically significant differences between students in the experimental and control groups in academic achievement attributed to teaching using the Learning Cycle Strategy (7E's's) and in favor of the experimental group.

### Research Question Second and Discussion

There are no statistically significant differences at the significance level ( $\alpha = 0.05$ ) between the Mean Score of the grades of third-year secondary students in the science skills test base on method of teaching (Learning Cycle Strategy (7E's's), and Traditional method, and gender (male and female).

For answering the Third hypothesis, The Means and standard deviations of the study sample's performance on the pre-test and post-test of scientific skills were extracted due to the method (experimental, control) and gender (male, female), and the table (4.12) shows that.

*Table 3*

*Means, Standard Deviation and f the study sample's performance on the Post -test (scientific skills) according to the method and gender*

skills	Group	Gender	Mean	Standard Deviation	N
Post Observation	experimental	Male	2.87	1.279	30
		Female	3.22	0.870	32
		Total	3.05	1.093	62
	Control	Male	2.80	1.064	30
		Female	2.73	2.463	30
		Total	2.77	1.881	60
	Total	Male	2.83	1.167	60
		Female	2.98	1.824	62
		Total	2.91	1.532	122
Post Classification	experimental	Male	1.73	1.015	30
		Female	2.47	.9830	32
		Total	2.11	1.057	62
	Control	Male	2.00	.8710	30
		Female	1.63	1.066	30
		Total	1.82	.9830	60
	Total	Male	1.87	.9470	60
		Female	2.06	1.099	62

		Total	1.97	1.028	122
	experimental	Male	1.87	.9730	30
		Female	1.81	1.148	32
		Total	1.84	1.059	62
PostPrediction	Control	Male	1.30	1.055	30
		Female	1.77	.8580	30
		Total	1.53	.9820	60
	Total	Male	1.58	1.046	60
		Female	1.79	1.010	62
		Total	1.69	1.029	122

Table 3  
(Continued)

skills	Group	Gender	Mean	Standard Deviation	N
Post Conclusion	experimental	Male	2.50	1.383	30
		Female	3.47	1.016	32
		Total	3.00	1.293	62
	Control	Male	3.07	1.530	30
		Female	2.93	1.112	30
		Total	3.00	1.328	60
	Total	Male	2.78	1.474	60
		Female	3.21	1.088	62
		Total	3.00	1.305	122
Post Use of numbers	experimental	Male	.800	.6100	30
		Female	1.31	.6930	32
		Total	1.06	.6980	62
	Control	Male	.870	.7760	30
		Female	.930	.6400	30
		Total	.900	.7060	60
	Total	Male	.830	.6930	60
		Female	1.13	.6890	62
		Total	.980	.7040	122
Post data Explanation	experimental	Male	1.43	.9350	30
		Female	1.91	.5880	32
		Total	1.68	.8050	62
	Control	Male	1.20	.7140	30
		Female	1.60	.814	30
		Total	1.40	.785	60
	Total	Male	1.32	.8330	60
		Female	1.76	.71700	62
		Total	1.54	.804	122
Post Experimentation	experimental	Male	1.07	.740	30
		Female	1.38	.707	32
		Total	1.23	.7340	62

Table 3  
(Continued)

skills	Group	Gender	Mean	Standard Deviation	N
	Control	Male	1.23	.626	30
		Female	.770	.679	30
		Total	1.00	.6890	60
	Total	Male	1.15	.685	60
		Female	1.08	.7530	62
		Total	1.11	.718	122
	experimental	Male	12.27	3.30	30
		Female	15.56	1.703	32
		Total	13.97	3.067	62
	Total	Male	12.47	3.267	30
		Female	12.37	3.943	30
		Total	12.42	3.590	60
	Control	Male	12.37	3.257	60
		Female	14.02	3.385	62
		Total	13.20	3.411	122

Table 3 shows an apparent discrepancy between the Means and the standard deviations of the students' scores in the Post-test scientific skills due to the different categories of method variables (experimental, control) and gender (male, female), and to reveal the significance of the statistical differences between the Means circles for the performance of the study sample on the post-test. Two-way MANOVA analysis was used for the sub-scientific skills, and Two-Way ANOVA analysis of the total score for the test, and the Tables 4 this.

Table 4

*Two-Way MANOVA analysis of the effect of method, gender and the interaction between them on the performance of the study sample on the scientific skills of the Post-test*

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Method Hotelling's = 0.129 Sig: 0.053	Post Observation	2.322	1	2.322	.980	.32	.008
	Post Classification	2.465	1	2.465	2.533	.11	.021
	Post Prediction	2.858	1	2.858	2.764	.01	.023
	Post Conclusion	.0070	1	.0070	.0050	.95	.000
	Post Use of numbers	.7440	1	.7440	1.596	.21	.013
	Post Explanation data	2.218	1	2.218	3.735	.06	.031
	Post Experimentation	1.486	1	1.486	3.126	.08	.026
Gender Hotelling's = 0.166 Sig: 0.014	Post Observation	.621	1	.6210	.2620	.61	.002
	Post Classification	1.036	1	1.036	1.065	.30	.009
	Post Prediction	1.296	1	1.296	1.254	0.27	.011
	Post Conclusion	5.317	1	5.317	3.282	0.07	.027
	Post Use of numbers	2.556	1	2.556	5.482	.02	.044

	Post Explanation data	5.806	1	5.806	9.775	.00	.076
	Post Experimentation	.191	1	.1910	.4020	.53	.003
Method*gender	Post Observation	1.336	1	1.336	.564	.45	.005
	Post Classification	9.254	1	9.254	9.512	.00	.075
Wilks' Lambda = 0.825	Post Prediction	2.067	1	2.067	1.999	.16	.017
							Sig: 0.003

Table 4.18  
(Continued)

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
	Post Conclusion	9.254	1	9.254	5.711	.02	.046
	Post Use of numbers	1.514	1	1.514	3.249	.07	.027
	Post Explanation data	.041	1	.041	.068	.79	.001
	Post Experimentation	4.576	1	4.576	9.625	.00	.075
Error	Post Observation	279.602	118	2.370			
	Post Classification	114.802	118	.9730			
	Post Prediction	122.008	118	1.034			
	Post Conclusion	191.202	118	1.620			
	Post Use of numbers	55.008	118	.4660			
	Post Explanation data	70.085	118	.5940			
	Post Experimentation	56.100	118	.4750			
Total	Post Observation	284.008	121				
	Post Classification	127.869	121				
	Post Prediction	128.164	121				
	Post Conclusion	206.000	121				
	Post Use of numbers	59.967	121				
	Post Explanation data	78.295	121				
	Post Experimentation	62.393	121				
	Total	1407.877	121				

Table (4) shows the following:

There are no statistically significant differences ( $\alpha = 0.05$ ) between the performance scores of the study sample in the sub-scientific skills of the post-test, with the exception of the total skills, in which the differences were attributed to the method, and in favor of the experimental group. The results also show There are no statistically significant differences ( $\alpha = 0.05$ ) between the performance scores of the study sample on the sub-scientific skills of the Post-test due to gender, except for the skills of use of numbers, explanation data and

overall skills, and the differences came in favor of females. The results are also show There are statistically significant differences ( $\alpha = 0.05$ ) between the means for the performance of the study sample on the sub-scientific skills of the post-test due to the interaction between method and gender, except for the skill of observation, prediction, use of numbers and explanation data.

Table 5

*Two-way ANOVA analysis of the effect of method, gender and the interaction between them on the performance of the study sample on the Post- test of scientific skills*

Source	Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Method	68.381	1	68.381	6.919	.01	.055
Gender	77.816	1	77.816	7.874	.01	.063
Method*gender	87.860	1	87.860	8.890	.01	.070
Error	1166.175	118	9.883			
<b>Total</b>	<b>1407.877</b>	<b>121</b>				

There is a statistically significant difference ( $\alpha = 0.05$ ) between the scores of students' performance on the post-test of scientific skills as a whole due to the method, where the F-value amounted to (6.919) with statistical significance (.01), and the differences were in favor of the experimental method. This result means rejecting the third null hypothesis, and accepting the alternative hypothesis which states that "there are statistically significant differences at the significance level ( $\alpha = 0.05$ ) on the post-test of scientific skills as a whole due to the effect of method, gender and the interaction between them.

It may be attributed to the nature, organization and construction of the content of the lessons that were designed according to the Learning Cycle Strategy (7E's's), so that they include introductory activities that include introductory experiments, worksheets and idea organizers that help build and organize the student's ideas, and conscious and active reading. The lessons also encourage practicing science as scientists' practice it, which helped students realize the importance of scientific skills, practice them and then develop them through the stages of the Learning Cycle Strategy (7E's's).

The researcher may attribute this to the fact that the nature of the seven-year learning cycle is suitable for developing scientific skills among third-year secondary school students, given the successive and consecutive stages it includes, and the research and investigation activities it requires, as well as group activities that require collecting data, analyzing it, discussing it, interpreting it, and expanding it to other situations, which helps them develop scientific skills.

The Learning Cycle Strategy (7E's's) also pushed the learner to participate actively; he discusses, experiments, researches, analyzes, infers, evaluates, and judges, so his learning became a continuous chain of continuous learning episodes. The Learning Cycle Strategy (7E's's) also prepared a qualitative shift for him by interacting with his teacher and colleagues, discussing, commenting, presenting his point of view, and participating in planning, preparation, and implementation of the activities he practices. Also, through the training and activities assigned to the students of the experimental group, who studied using the Learning Cycle Strategy (7E's's), it made them adopt the approach of group work so that the student participates with his colleagues in activities and assignments that require group participation

to solve, and this enhances the aspect of learning from peers, which contributes to increasing learning.

It may be interpreted that one of the most important characteristics of the Learning Cycle Strategy (7E's's) is that it prepares the learner to rely on himself and achieve his self, so he can make his decision with insight and conviction, and it also enables him to choose the educational path that suits his abilities and potential, and leads him to the factors of excellence and creativity with a critical, insightful, lively and interactive mind. The reason may also be that teaching using the Learning Cycle Strategy (7E's's) for students in the experimental group allowed the learner to use more than one sense in education.

The reason for the superiority of the Learning Cycle Strategy (7E's's) in teaching over the traditional method of acquiring scientific skills may be due to the fact that teaching according to this strategy is based on the interaction of students through their learning in cooperative groups, giving them the freedom to learn, and their analysis of topics and lessons and finding relationships between concepts and linking them. This has led to increased encouragement for them during educational situations, reaching sound scientific results, writing them down, reading them, discussing them, and reviewing them to ensure their correctness and selecting the best of them, then taking feedback on these ideas from their peers inside the classroom, and from the teacher, and rewriting and classifying them. This is evident from what is provided by the mechanisms and steps of the seven-step learning cycle strategy (2006). Bybee et al. Not only that, but this superiority may be due to what the teaching procedures provide according to this strategy by presenting information, ideas, and basic and secondary concepts and analyzing them at the beginning of each lesson in the form of problems that encourage students to adopt them, study them carefully, and link them to their ideas and build on them. This may help them realize the common characteristics and relationships between knowledge, ideas, and information. This may work to draw students' attention to the topic of the lesson, identify the main concepts and ideas in the problem, and activate the role of investigation in reaching a solution to the problem. This contributes to the use of various related scientific skills and the use of specific and clear steps in the learning processes.

The tasks presented in the seven-cycle learning strategy raise many thought-provoking questions and allow for the practice of higher mental skills, which may have contributed to the development of scientific skills among students. This superiority may be attributed to what the seven-cycle learning cycle achieves in promoting meaningful learning, represented by giving students the opportunity for cognitive activity, analysis and linking of knowledge and building on their previous concepts, as large educational tasks are tested in smaller tasks, and this is an advantage through which students can succeed in the tasks given to them, which means giving students a strong motivation to complete larger tasks.

This result is consistent with the study of Choirunnisa, Prabowo, & Suryanti (2018), which indicated an increase in student learning rates as a result of using the Learning Cycle Strategy (7E's's), and an improvement in scientific skills due to the use of the Learning Cycle Strategy (7E's's). and This study is consistent with the results of the study Al-Masha'la (2018) showed that there were statistically significant differences between the average performance scores of the two study groups on the scientific skills acquisition test, attributed to the teaching strategy variable.

**Recommendations**

Based on the findings of this study, the following recommendations are made:

Chemistry teachers in secondary schools are needed to be more innovative and resourceful in identifying, selecting, and using activity-based instructional strategies in a chemistry class. To be able to do this, teachers will need to be trained by discipline-based educational strategists.

Building enrichment activities according to the Learning Cycle Strategy (7E's's) for all scientific subjects and all educational stages. This recommendation is directed to the Curriculum Administration at the Ministry of Education, and holding courses for chemistry teachers on how to design and implement lessons according to the Learning Cycle Strategy (7E's's).

**References**

- Abdullahi, A. C., Jibrin, A. G., Dauda, M. O., & Danjuma, I. M. (2021). Effect of 7E'ss learning strategy on retention secondary school students in biology in Bauchi Metropolis, Bauchi State, Nigeria. *Global Journal of Education, Humanities & Management Sciences*, 3(1).
- Al-Harbi, A. (2017). A program effectiveness based on the E-Learning to give the basic unit of chemical concepts (Electrochemistry) in the development of scientific thinking among Secondary School Students. *Journal of Educational and Psychological Sciences*, 10(4), 1131- 1167.
- Ali, M. T., Woldu, A. R., & Yohannes, A. G. (2022). High school students' learning difficulties in electrochemistry: a mini review. *African Journal of Chemical Education*, 12(2), 202-237.
- Aljuwayr, Y. F. M. (2018). Investigating Saudi Arabian high school science teachers perceived challenges and concerns related to the integration of science content, technology, engineering, and mathematics (STEM) into science teaching (Doctoral dissertation).
- Alkahtani, A. (2017). The challenges facing the integration of ICT in teaching in Saudi secondary schools. *International Journal of Education and Development using ICT*, 13(1).
- Alnahdi, G. H., & Schwab, S. (2023). The impact of gender differences in teachers' teaching practices and attitudes on students' math and science achievement in Saudi Arabia: Evidence from TIMSS 2019 data. *Frontiers in Psychology*, 14, 1066843.
- Alqahtani, W. (2023). Science Teachers' Views of Inquiry-Based Teaching and Critical Thinking Skills in Saudi Middle Schools (Doctoral dissertation, University of Kansas).
- Alsubaie, M. A. (2015). Hidden curriculum as one of current issue of curriculum. *Journal of Education and practice*, 6(33), 125-128.
- Amponsah, K. D. (2020). South African twelfth grade students' conceptions regarding Electrochemistry. *Journal of Education and Learning (EduLearn)*, 14(3), 362-368.
- Choirunnisa, N. L., Prabowo, P., & Suryanti, S. (2018, January). Improving science process skills for primary school students through 5E instructional model-based learning. In *Journal of Physics: Conference Series* 947, p. 012021.
- Doménech-Carbó, A., Martini, M., Di Turo, F., de Silveira, G. D., & Montoya, N. (2024). Electrochemistry for non-electrochemists: a postgraduate formative project. *Journal of Solid State Electrochemistry*, 28(3), 1069-1083.
- Elia, R., Solfema, S., Miaz, Y., & Zen, Z. (2024). Improving Concept Understanding and Learning Outcomes of Elementary School Students through Science Textbooks Based on Learning Cycle 7E's Model. *Jurnal Penelitian Pendidikan IPA*, 10(7), 4433–4441.

- Elsayed, M. A., Clerkin, A., Pitsia, V., Aljabri, N., & Al-Harbi, K. (2022). Boys' underachievement in mathematics and science: An analysis of national and international assessment data from the Kingdom of Saudi Arabia. *Large-scale Assessments in Education*, 10(1), 23.
- Gong, X., Bergey, B. W., Jin, Y., Mao, K., & Cheng, Y. (2023). Gender differences in high school students' perceived values and costs of learning chemistry. *Chemistry Education Research and Practice*, 24(1), 203-216.
- Lee, T. T., & Osman, K. (2011, December). Effectiveness of interactive multimedia module with pedagogical agent (IMMPA) in the learning of electrochemistry: A preliminary investigation. In *Asia-Pacific Forum on Science Learning & Teaching* (Vol. 12, No. 2).
- Lu, S., Bi, H., & Liu, X. (2019). A phenomenographic study of 10th grade students' understanding of electrolytes. *Chemistry Education Research and Practice*, 20(1), 204-212.
- Maashi, K. M., Kewalramani, S., & Alabdulkareem, S. A. (2022). Sustainable professional development for STEM teachers in Saudi Arabia. *Eurasia Journal of Mathematics, Science and Technology Education*, 18(12), em2189.
- Morris, D. L. (2025). Rethinking Science Education Practices: Shifting from Investigation-Centric to Comprehensive Inquiry-Based Instruction. *Education Sciences*, 15(1), 73.
- Musfiroh, M., Suwarma, I. R., & Efendi, R. (2024). Enhancing physics learning through the 7E's learning cycle model: A systematic literature review. *Indonesian Journal of Science and Mathematics Education*, 7(3), 531-544.
- Musfiroh, M., Suwarma, I. R., & Efendi, R. (2024). Enhancing physics learning through the 7E's learning cycle model: A systematic literature review. *Indonesian Journal of Science and Mathematics Education*, 7(3), 531-544.
- Nakiboglu, C., Rahayu, S., Nakiboğlu, N., & Treagust, D. F. (2024). Exploring senior high-school students' understanding of electrochemical concepts: patterns of thinking across Turkish and Indonesian contexts. *Chemistry Education Research and Practice*, 25(1), 42-61.
- Nicol, C., Gakuba, E., & Habinshuti, G. (2020). An overview of learning cycles in science inquiry-based instruction. *African Journal of Educational Studies in Mathematics and Sciences*, 16(2), 76–81.
- Nicol, C., Gakuba, E., & Habinshuti, G. (2020). An overview of learning cycles in science inquiry-based instruction. *African Journal of Educational Studies in Mathematics and Sciences*, 16(2), 76–81.
- Noreen, Z., Iqbal, M., & Hayat, K. (2024). Effect of the 7E's Learning Cycle Model on Students' Achievement in the Subject of Science at the Elementary School Level. *Qlantic Journal of Social Sciences*, 5(2), 34-45.
- Omeje, C. O. (2023). Effect of Project-Based Learning on secondary school students' academic achievement in electrochemical cells in Agbani Education Zone. *Journal of Science Education (JOSCED)*, 4(1), 31-41.
- Rampean, B., Roheti, E., & Lengkong, M. (2021, March). How Can Open Inquiry Enhancing Students' Scientific Attitude Through Chemistry Learning?. In *7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS 2020)* (pp. 238-245). Atlantis Press.
- Santi, M. T., & Atun, S. (2021). Learning activities based on learning cycle 7E's model: Chemistry teachers' perspective. In *Proceedings of the 6th International Seminar on Science Education (ISSE 2020)* (pp. 234–240). Atlantis Press.
- Tabachnick, B. G., & Fidell, L. S. (2019). *Using Multivariate Statistics* (7th ed.). Pearson.

- Tannous, A. (2014). the effect of using teaching strategy (7E's's) on understanding scientific concepts and acquisition inquiry thinking skills among basic stage students in the light of their academic self-concept as compared with the traditional method. *Journal of Al-Quds Open University for Educational and Psychological Research and Studies*, 2(8), 127-160.
- Tsaparlis, G. (2019). Teaching and learning electrochemistry. *Israel Journal of Chemistry*, 59(6-7), 478-492.
- Vidal-Iglesias, F. J., Solla-Gullón, J., Rodes, A., Herrero, E., & Aldaz, A. (2012). Understanding the Nernst equation and other electrochemical concepts: an easy experimental approach for students. *Journal of Chemical Education*, 89(7), 936-939.