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The Impact of the K.W.L Strategy on the Achievement of Chemistry among First-Year Intermediate Students

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Abstract: Background: This study aimed to investigate the effect of the K.W.L. strategy on improving academic achievement in chemistry among first-grade intermediate school students. This was achieved by testing the following null hypothesis: There is no statistically significant difference at a significance level ($0.05 \geq \alpha$) between the mean scores of the experimental group students who studied using the K.W.L. strategy and the mean scores of the control group students who studied using the conventional method on a chemistry achievement test. **Method:** The researchers employed a quasi-experimental method with a post-test design for two independent, equivalent groups. A random sample of (60) first-grade intermediate school students was selected from schools in the Al-Karkh II Directorate of Education in Baghdad Governorate for the academic year (2022-2023). Class (D) was assigned as the experimental group (N=30), which was taught using the K.W.L. strategy, and class (E) was assigned as the control group (N=30), which was taught using the conventional method. The equivalence of the two groups was verified prior to the commencement of the experiment. The research instruments included the development of (95) behavioral objectives for Chapter Four of the first-grade intermediate science textbook (Chemical Reactions and Their Representation) and the preparation of (12) teaching plans for each group. The researcher taught both groups during the research application period. **Results:** The data analysis results revealed statistically significant differences at a significance level ($0.05 \geq \alpha$) between the mean scores of the experimental group) (M=35.621, SD=1.896) and the mean score of the control group (M=20.845, SD=7.875) on the chemistry academic achievement test, in favor of the experimental group. **Conclusion:** The findings indicate the effectiveness of the K.W.L. strategy in enhancing academic achievement in chemistry among first-grade intermediate school students. Based on these results, the researchers recommended the necessity of utilizing the K.W.L. strategy in teaching various science subjects, effectively integrating active learning strategies, including K.W.L., into the intermediate stage curricula, and the importance of training teachers on the use of these modern strategies.

Keywords: Chemistry Education, Student Performance, Metacognitive Strategies, K.W.L. Strategy, Achievement.

أثر استراتيجية K.W.L في تحصيل مادة الكيمياء عند طلاب الصف الاول المتوسط

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الملخص: الخلفية: هدفت هذه الدراسة التحقق من أثر استراتيجية (K.W.L) في تحسين التحصيل الدراسي في مادة الكيمياء لدى طلاب الصف الاول المتوسط من خلال التحقق من صحة الفرضية الصفرية الاتية: • لا يوجد فرق ذو دلالة احصائية عند مستوى دلالة ($0.05 \geq \alpha$) بين متوسطات درجات طلاب المجموعة التجريبية الذين درسوا باستخدام استراتيجية (K.W.L) ومتوسطات درجات طلاب المجموعة الضابطة الذين درسوا بالطريقة الاعتيادية في اختبار التحصيل في مادة الكيمياء. الطريقة: اعتمدت الباحثتان المنهج شبه التجريبي بتصميم الاختبار البعدي لمجموعتين مستقلتين متساويتين. تم اختيار عينة عشوائية مكونة من (60) طالبا من طلاب الصف الأول المتوسط في مدارس محافظة بغداد / الكرخ الثانية للعام الدراسي (2023/2022)، حيث تم تخصيص شعبة (د) كمجموعة تجريبية (N=30) درست باستخدام استراتيجية (K.W.L)، وشعبة (هـ) كمجموعة ضابطة (N=30) درست بالطريقة الاعتيادية. تم التحقق من تكافؤ المجموعتين قبل البدء بالتجربة. شملت أدوات البحث اعداد (95) هدفا سلوكيا للفصل الرابع من كتاب العلوم للصف الأول المتوسط (التفاعلات الكيميائية والتعبير عنها) واعداد (12) خطة تدريسية لكل مجموعة. قام الباحث بتدريس المجموعتين من خلال فترة تطبيق البحث. **النتائج:** أظهرت نتائج تحليل البيانات وجود فروق ذات دلالة إحصائية عند مستوى دلالة ($0.05 \geq \alpha$) بين متوسطات درجات طلاب المجموعة التجريبية (M=35.621, SD=1.896) ومتوسط درجات طلاب المجموعة الضابطة (M=20.845, SD=7.875) في اختبار التحصيل الدراسي لمادة الكيمياء لصالح المجموعة التجريبية. **الخلاصة:** تشير النتائج الى فعالية استراتيجية (K.W.L) في تحسين التحصيل الدراسي في مادة الكيمياء لدى طلاب الصف الأول المتوسط. بناء على هذه النتائج أوصت الباحثتان بضرورة استخدام استراتيجية (K.W.L) في تدريس مواد العلوم المختلفة، وتضمين استراتيجيات التعلم النشط بما فيها (K.W.L) بشكل فعال في مناهج المرحلة المتوسطة، بالإضافة الى ضرورة تدريب المعلمين على استخدام هذه الاستراتيجيات الحديثة.
الكلمات المفتاحية: تعليم الكيمياء، أداء الطالب، استراتيجيات ما وراء المعرفة، استراتيجية K.W.L، التحصيل.

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Introduction

Education is essential for both the learner and society, as it forms the basis for their development, progress, evolution, and construction on sound scientific foundations. It is their primary means for survival, continuity, and their ability to confront the challenges and emerging issues they face. (Al-Ja'afreh, 2013: 21)

This is what distinguishes chemistry from other subjects. It is involved in all areas of life and influences all other sciences. It investigates chemical reactions and introduces changes to them. The purpose of teaching chemistry in educational stages is to provide learners with the basic information that helps them understand the natural phenomena occurring around them. It also aims to develop their observational skills and cultivate a scientific approach that links results with causes and reality with theories based on induction, comprehension, and deduction. Thus, it is necessary to implement modern teaching strategies and methods in presenting concepts to learners to keep pace with the developments in this era characterized by the proliferation of knowledge, technology, and the accumulation of various life problems. (Al-Zubaidi, 2016: 37)

Teaching strategies based on constructivist theory emphasize the connections between what the learner learns, their prior thoughts and experiences, and their cognitive skills in perceiving and organizing those connections. They posit that learning is effective when the learner feels that it is meaningful and that meaningful learning is fundamental to behavior modification. (Attia, 2009: 239)

Therefore, innovation in teaching methods is no longer just a matter of discussion but has become an urgent and vital necessity to create a balance between the changes in the era of globalization and the role that educational systems should play. Attention to selecting the best teaching strategies that consider the unique characteristics of each learner is crucial. Teaching that disregards the actual abilities, inclinations, attitudes, readiness, needs, and desires of learners cannot achieve educational objectives, regardless of the quality and proficiency of the teaching. A teacher's knowledge of the learner's cognitive abilities, level of achievement, scientific, cultural, economic, and social backgrounds, and awareness of their attitudes, interests, and values makes them more interactive and communicative with learners, consequently positively affecting student performance. (Al-Shafei, 2009: 92)

Based on the above, this study came to investigate the impact of the [K.W.L] strategy on students' learning in first-year intermediate chemistry in Baghdad, with a focus on the importance of metacognitive strategies in enhancing this impact."

Research Problem

All facets of life are seeing incredible development, which motivates nations and peoples to concentrate their attention and efforts on staying up to date with the technical breakthroughs and explosion of information taking place in a variety of fields. One of these fields that has seen a lot of development and attention is education. Given its close relationship to human life and society, chemistry, a highly specialized discipline with several branches, plays an essential role. This emphasizes how crucial it is to teach this subject in a way that shows its applicability to the environment and life of the student. Thus, one of the biggest issues facing teachers is the drop in chemistry student performance. The poor chemistry achievement rates among first-year middle school pupils serve as evidence of that.

According to a study by Jabbar (2023), Hammad (2023), Abd El-Aziz etal (2025) and Jabbar (2019), typical teaching approaches in science education are ineffective. Instead of emphasizing the student's action, thought, and involvement, these approaches frequently concentrate on the content, especially on memory and recall of knowledge.

What is the effect of the (K.W.L) strategy on the achievement of first-year intermediate students in chemistry?

Research Objectives

The current study aims to investigate the impact of the (K.W.L) strategy on the chemistry achievement of first-grade middle school students.

Research Hypothesis

There is no statistically significant difference at the ($0.05 \geq \alpha$) level between the average scores of the experimental group students, who are taught using the (K.W.L) strategy, and the average scores of the control group students, who are taught using the conventional method, in the chemistry achievement test.

Research Limits

- **Human limits**: First-grade middle school students in the Al-Karkh Second District of Baghdad.
- **Cognitive limits**: Chapter (Four) of the science textbook (chemistry) for first-year middle school, as adopted for teaching, 5th edition (2021), Ministry of Education, Republic of Iraq.
- **Temporal limits**: The second semester of the 2024/2023 academic year.

Definition of Terms

K.W.L Strategy (Know, Want to Learn, Learned): It is defined by (Atiya, 2009) as: A strategy from metacognitive and active learning strategies, which involves the reader's ability to recognize what they know and what they do not know, and the reader's awareness of the cognitive processes applied during the reading situation. It is based on activating prior knowledge in the learner and utilizing it in the process of new learning. (Atiya, 2009: 60).

Operational Definition: It is one of the active learning strategies, consisting of a series of sequential steps that students apply during their studies. It helps teachers retrieve the prior knowledge students possess by engaging them in a brainstorming session on the lesson topic before introducing new learning. It helps students form sound, cohesive, and interconnected cognitive structures.

Achievement: It is defined by (Alam, 2018) as: "The degree or level of success a student achieves in a specific academic field. It represents the acquisition of knowledge and skills and the ability to use them in present or future situations. It is the final outcome of learning." (Alam, 2018: 123).

Operational Definition: It is defined as: "The final result of what the research sample students have acquired in Chemistry for the first-year middle school, measured by the score they obtained in the achievement test at the end of the research experiment."

Constructivist Theory

One of the cognitive theories that puts the student at the center of the learning process is constructivist theory. Through social negotiation, the learner makes connections between new and old experiences through practical and experimental activities.

The constructivist theory emerged from the works of Piaget and Ausubel, which explained how knowledge is constructed. It was later developed by Joseph Novak and his colleagues, who organized the constructivist theory that emerged from the works of Piaget and Ausubel, which explained how knowledge is constructed. It was later developed by Joseph Novak and his colleagues, who organized the

cognitive structure into concept maps.e cognitive structure into concept maps. (Al-Sarouh *et al*., 2021: 43-44)

Active Learning

Active learning is a key educational and psychological strategy that has become popular in middle and high schools. Emerging in the late twentieth century, it encourages active engagement and a positive learning atmosphere. Its main components are speaking and listening, writing, reading, and reflection.

Active learning fosters student participation, stimulates original thought, and teaches the use of contemporary classroom technology. It enhances critical thinking, problem-solving, and the exchange of ideas on instructional topics. Students develop collaboration skills, creativity, and practical application of theoretical knowledge, while teachers guide, mentor, and facilitate the learning process.

Model (1): The difference between K.W.L and PBL.

	K.W.L	PBL
Concept Definition	A three- step strategy 1. K (Know) 2. W (Want to know) 3. L (Learned)	Project-Based Learning: students engage in real-world projects requiring inquiry and problem-solving.
Objective	Activate prior knowledge and guide thinking.	Develop critical thinking, problem-solving, and self-directed learning.
Implementation Steps	(K) Recall prior knowledge – (W) Generate questions – (L) Summarize learning.	Identify problem – Research and analysis – Develop solutions – Apply and evaluate.
Skill Development	Critical thinking, comprehension, self-correction.	Critical thinking, collaboration, life skills, autonomous learning.
Teacher's Role	Facilitator, question stimulator, corrects misconceptions.	Mentor, guide, provider of resources.
Learner's Role	Active participant, questioner, self-evaluator.	Researcher, problem analyst, innovator, collaborator.
Assessment	Formative assessment (questions, discussion, brainstorming).	Holistic evaluation (final product, peer review, project outcomes).

The KWL strategy was preferred over PBL due to its:

1. Theoretical focus: Suitability for understanding complex theoretical concepts.
2. Efficiency: Not requiring complex practical projects.
3. Critical thinking: Encouraging analytical thinking and problem-solving skills.

Steps of K.W.L strategy

Atieh (2009, p. 253) explains that the K.W.L strategy involves these stages:

1. Topic Announcement and Overview: The teacher writes the topic title on the board with a brief overview.
2. Displaying the Table: The teacher draws the table on the board and reminds students how to use each column.
3. Choosing Study Method: Group work is preferred over whole-class instruction.
4. Filling the First Column – What Do We Know? Students list their prior knowledge about the topic.
5. Defining What to Learn: Students write questions they want to answer during or after studying the topic.
6. In-Depth Study: Students explore the topic using prior knowledge and questions as a guide.
7. Recording What Was Learned: Students complete the third column with answers to "What did I learn?"
8. Evaluation: Students compare what they learned with their initial questions, address misconceptions, and assess their progress.

Stages of the K.W.L Strategy

This strategy consists of three stages, with each letter representing a different aspect of the thinking process and the stages of knowledge development, as follows:

First stage K: Represents the word "Know" in the question: "What do I know about the subject?" (Previous knowledge).

Second stage W: Represents the word "Want" in the question: "What do I want to know about the subject?" (Intended knowledge).

Third stage L: Represents the word "Learned" in the question: "What did I learn about the subject?" (Acquired knowledge), (Tawleba, 2010, p. 110).

From the above, this strategy helps students gain more learning, discovery, and research by exploring additional learning sources to expand their knowledge and experiences on the topic, (Al-Rubaie, 2011, p. 44).

Role of the Teacher in the K.W.L Strategy

- Uncovering students' prior knowledge as a foundation for new learning.
- Facilitating discussions and generating questions to stimulate students' thinking.
- Guiding, evaluating, and correcting students' performance and their achievement of learning goals.
- Providing opportunities to encourage students' self-directed learning and independent study. (Atieh, 2009: 175)

Role of the Learner in the K.W.L Strategy

- Reading and comprehending the topic and understanding the presented ideas.
- Asking questions to address knowledge needs or seek answers.
- Engaging in discussion to verify the correctness of information.
- Correcting prior misconceptions in their cognitive structure.
- Practicing both individual and collaborative thinking with peers.
- Categorizing ideas on the topic into main and subtopics. (Al-Harbi, 2021: 474)

Literature Review

This section reviews previous studies related to the impact of the K.W.L strategy on academic achievement.

First: Studies on the K.W.L Strategy

1. Al-Muzaydi (2019): Examined the effect of teaching science and technology with the K.W.L strategy on (64) eleventh-grade female students (experimental vs. control). Results showed significant differences favoring the experimental group with a large effect size, supporting the current study's hypothesis, though in a different subject and grade level.
2. Al-Rawtli (2014): Investigated the strategy's impact on science achievement and metacognitive skills among (62) ninth-grade Omani students. Findings revealed significant improvements in both areas for the experimental group, highlighting the strategy's role in fostering metacognition and guiding student thinking.

Second: Studies on Academic Achievement

1. **Jabbar (2024):** Studied the effect of the TASK model on achievement and systemic thinking among (70) second-grade intermediate female students. Results showed significant superiority of the experimental group. Despite using a different model, findings align with the objectives of the K.W.L strategy in promoting active learning and deeper understanding.
2. **Jabbar Study (2023):** Investigated the effect of Quick Round and Expressive Sentences strategies on chemistry achievement and communication skills among (96) first-grade intermediate female

students in three groups (two experimental, one control). Results confirmed the strategies' effectiveness. The study's focus on communication aligns with the K.W.L strategy, which fosters interaction and idea exchange, suggesting its potential to enhance both communication and achievement in chemistry.

Methodology

The current research utilized a quasi-experimental design (partially controlled experimental design) to achieve the research goal, as it is suitable for testing the hypothesis. This methodology allows us to overcome issues related to the dependent or independent variables, which are tested through the hypothesis (Al-Munzail and Adnan, 2010: 207).

Experimental Design

The experimental design represents a detailed plan that enables us to answer the research question, provided that the steps, procedures, and stages included in the plan prepared by the researcher are followed (Al-Zuhairi, 2017: 343).

The quasi-experimental design (partially controlled experimental design for post-test of the two equivalent groups: control and experimental) was adopted, as it fits the nature of the research, which involves an independent variable (the K.W.L strategy) and a dependent variable (achievement), as shown in Table (1).

Table (1): Experimental Design.

Groups	Equivalence	Independent Variable	Dependent Variables	Post-test
Experimental	– Prior achievement in science – Previous knowledge – Age in months – Intelligence test	K.W.L Strategy	Academic achievement	Achievement test
Control		Traditional method		

Research Population

The research population consists of all first-year middle school students in public day schools affiliated with the Directorate of Education in Baghdad / Al-Karkh II for the academic year (2023-2024), totaling 3,683 students.

Research Sample

The research sample was selected from first-year middle school students at Al-Saber Boys' Middle School, located in the Dora area under the Directorate of Education in Baghdad / Al-Karkh II. The sample was chosen deliberately. Based on random selection, Section (D) represented the experimental group, consisting of 32 students, who would be taught using the K.W.L strategy. Section (E) represented the control group, consisting of (33) students, who would be taught using the traditional method. Therefore, the total sample size was 65 students. Students who failed were excluded from the sample, totaling (5) students (2) from Section (D) and (3) from Section (E) . The final number of students in the sample was (60).

Control Procedures

The researcher took steps to ensure equivalence in variables (intelligence, prior knowledge, previous achievement, and age in months) before conducting the experiment. Additionally, the research sample was randomly selected to avoid effects that might lead to inaccurate results. Therefore, the researcher was careful to control the variables affecting the application of the experiment and the validity of the results by ensuring the external and internal validity of the quasi-experimental design (partially controlled experimental design), as follows:

Internal Validity of the Experimental Design

This refers to minimizing extraneous variables. Hence, any differences between the

research groups in terms of the dependent variable are attributed to the independent variable, not to other causes (Myers, 1990: 59). This allows for any variation in the dependent variable to be attributed to the independent variable in the research.

Students' Age Calculated in Months: This refers to the students' age measured in months. Data related to this variable were obtained from the students' school records. The students' ages were calculated from their date of birth until Thursday, March 2, 2023, the afternoon of the experiment's start date. Consequently, the homogeneity of variances was required before using the t-test between the two research groups. The Levene's test for homogeneity of variances was used, as shown in Table (2).

Table (2): Levene's test results between the two research groups in the chronological age variable.

Group	Number	Mean	Levene's Test for Homogeneity Value	
			Calculated F Ratio	Tabulated F Ratio
Experimental	30	147.82	0.214	4.00
Control	30	147.53		

It is evident from Table (2) that there is no significant difference between the research groups; to determine the significance of the difference between the average ages of the students, a t-test was applied to the research samples. The calculated t value was (0.322), which is less than the tabulated t value (2) at the significance level of ($\alpha = 0.05$) with 58 degrees of freedom. This indicates that the research groups are equivalent in this variable, as shown in Table (3).

Table (3): Equivalence of the two groups in the chronological age variable.

Group	No	Mean	Standard Deviation	Degree of Freedom	Calculated t-value		Statistical Significance ($\alpha = 0.05$)
					Calculated value	Tabulated value	
Experimental	30	147.82	3.563	58	0.322	2	Not statistically significant
Control	30	147.53	3.981				

Intelligence Test (Otis-Lennon)

The researchers used the Otis-Lennon Test of Mental Abilities, standardized in the Iraqi context by Al-Quraishi (1990), to measure intelligence. It achieved a high degree of validity and reliability. The test consists of (50) diverse items, including (22) verbal items, (14) symbolic items, and (14) picture and figure items. The test consists of a multiple-choice item with five alternatives. It was administered on Sunday, March 5, 2023. Responses were calculated by assigning one point for a correct answer and zero for an incorrect or omitted answer, or for answering more than one option.

To verify the equivalence of the two research groups on this variable, homogeneity of variance was used between the two research groups. Accordingly, Levene's test was used, as shown in the table.

Table (4): Results of Levene's test for homogeneity of variance between the two research groups in intelligence scores

Group	Number	Mean	Levene's Test for Homogeneity Value	
			Calculated F Ratio	Tabulated F Ratio
Experimental	30	15.342	2.324	4.00
Control	30	14.70		

It is clear from Table (4) that there is no difference between the two research groups; to determine the significance of the difference between the average intelligence of the students, the t-test was used for the two research samples. The calculated t-value was (0.478), which is less than the tabular t-value (2) at the significance level ($\alpha = 0.05$) with 58

degrees of freedom. This indicates that the two research groups are equivalent in this variable, as shown in Table.(5)

Table (5): Equivalence of the two research groups in the intelligence variable.

Group	No	Mean	Standard Deviation	Degree of Freedom	Calculated t-value		Statistical Significance (α = 0.05)
					Calculated value	Tabulated value	
Experimental	30	15.342	4.817	58	0.478	2	Not statistically significant
Control	30	14.70	5.732				

Previous Achievement Scores in Chemistry

The researchers obtained the students' scores in Chemistry from the school records on Monday, March 6, 2023. Accordingly, the homogeneity of variances was required before using the t-test between the two research groups. Levene's test for homogeneity of variances was applied, as shown in Table.(6)

Table (6): Results of Levene's Test for Homogeneity of Variances between the Research Groups in Previous Achievement.

Group	Number	Mean	Levene's Test for Homogeneity Value	
			Calculated F Ratio	Tabulated F Ratio
Experimental	30	73.231	3.140	4.00
Control	30	73.243		

It is evident from Table (6) that there is no difference between the two research groups; to determine the significance of the difference between the average previous achievement scores, a t-test was used for the two research samples. The calculated t-value was (0.051), which is less than the tabular t-value (2) at the significance level (α = 0.05) with 58 degrees of freedom. This indicates that the two research groups are equivalent in this variable, as shown in Table.(7)

Table (7): Equivalence of the two research groups in the variable of previous achievement in science.

Group	No	Mean	Standard Deviation	Degree of Freedom	Calculated t-value		Statistical Significance (α = 0.05)
					Calculated value	Tabulated value	
Experimental	30	73.231	11.743	58	0.051	2	Not statistically significant
Control	30	73.243	8.547				

Previous Knowledge Test

In order to assess the prior knowledge of the research sample students in Chemistry regarding chemical concepts, which are important factors in the dependent variable, the researcher prepared an objective test for previous knowledge consisting of 20 multiple-choice items. The test was administered to the students of both research groups in the first week of the experiment, on Tuesday, March 7, 2023. The same question paper was used, and model answers were prepared for the test. The test was graded by awarding one point for each correct answer, and zero points for incorrect, unanswered, or ambiguous answers (i.e., answers containing two options). Accordingly, the homogeneity of variances was required before using the t-test between the two research groups. Levene's test for homogeneity of variances was applied, as shown in Table.(8)

Table (8): Results of Levene's Test for Homogeneity of Variances between the Research Groups in Previous Knowledge Variable.

Group	Number	Mean	Levene's Test for Homogeneity Value	
			Calculated F Ratio	Tabulated F Ratio
Experimental	30	10.213	0.623	4.00
Control	30	9.875		

It is evident from Table (8) that there is no difference between the two research groups, to determine the significance of the difference between the average previous knowledge of the students, a t-test was used for the two research samples. The calculated t-value was (0.514), which is less than the tabular t-value (2) at the significance level (α = 0.05) with 58 degrees of freedom. This indicates that the two research groups are equivalent in this variable, as shown in Table.(9)

Table (9): Equivalence of the two research groups in the prior information variable.

Group	No	Mean	Standard Deviation	Degree of Freedom	Calculated t-value		Statistical Significance (α = 0.05)
					Calculated value	Tabulated value	
Experimental	30	10.213	2.513	58	0.514	2	Not statistically significant
Control	30	9.875	2.342				

Distribution of Study Periods

The distribution of study periods was equal between the two research groups, with two sessions per week for each group, as agreed upon with the school administration. Table (10) clarifies this.

Table (10): Distribution of Study Periods.

Group	Days	Session	Time
Experimental	Sunday Monday	First Second	45 minutes
Control	Sunday Monday	Second Third	45 minutes

Research Requirements

Defining the Scientific Material: The researchers defined the scientific material to be taught to the students of both research groups, which was determined in Chapter 4 of the Chemistry textbook.

Formulation of Behavioral Objectives: The researchers formulated a number of behavioral objectives based on the content of the scientific material, totaling 95 objectives according to Bloom's taxonomy in the cognitive domain (knowledge, understanding, application, analysis). An agreement ratio of 80% or more among the judges was required to accept a behavioral objective. All behavioral objectives were approved. These objectives were used to construct the achievement test and prepare the teaching plans, as shown in Table .(11)

Table (11): Behavioral Objectives for the Achievement Test.

Level / Content	Bloom's Levels					Total
	Remembering	Understanding	Applying	Analyzing	Synthesizing	
Chemical Reactions	14	9	6	1	1	31
Expression of Chemical Reactions	3	1	2	0	0	6
Balancing Chemical Equations	2	1	1	1	0	5
Chemistry in Our Life	24	20	2	4	3	53
Total	43	31	11	6	4	95

Determination of Study Sessions

The study session titles were determined to be two sessions per week, lasting for 6 weeks, making the total number of study sessions (24).

Preparation of Teaching Plans: A total of 12 teaching plans were prepared for each group (experimental and control) based on the content of Chapter 4 of the prescribed science book for first-year middle school students for the academic year (2022-2023) and the behavioral objectives. The experimental group's plan included presenting the material and conducting experiments using a model. The teaching plans for the control group, which was

taught using the traditional method, contained the daily lesson plan details.

Teacher Bias in KWL Strategy

- Teacher Bias in Questioning: Teacher bias may influence the questions asked, potentially directing students towards specific answers.
- Bias in Assessment: Teacher bias may affect the evaluation of student responses, potentially leading to unfair assessment.
- Bias in Support: Teacher bias may influence the support provided to students, potentially leading to inadequate support for some students.

Overcoming these Limitations

- Awareness of Bias: Teachers should be aware of their potential biases and work to minimize their impact.
- Providing Appropriate Support: Teachers should provide suitable support for students, including additional resources for those who need them.
- Adapting the Strategy: Teachers should adapt the KWL strategy to meet the needs of all students.
- Fair Assessment: Teachers should assess student responses fairly, considering differences in understanding and learning styles.

Seventh - Research Tool

The researchers used the achievement test as the tool to measure the dependent variable for the students in both research groups. After extracting the psychometric properties of the test, it was applied to the research sample. Below are the procedural details:

Achievement Test

The researchers prepared an objective test in the form of multiple-choice questions to measure the achievement of first-year middle school students and assess how well the research sample acquired knowledge and progressed.

Steps in Building the Achievement Test

Defining the Test Objective: The objective of the test is to measure the achievement of the research sample students in the content of the chemistry subject from the science book for first-year middle school students.

Determining the Test Items: A total of 20 test items were selected from the content of the chemistry book for the second semester.

Preparing the Test Specification Map (Test Map): The test blueprint is a two-dimensional plan in which the number of questions in each cell is determined based on the content and objective. The test map provides the test designer with a framework for constructing the test and indicates the number of questions needed to measure each type of objective in all content aspects (Ali, 2005: 34). Therefore, a specification table for the achievement test was prepared, and the cognitive level weights were determined based on the behavioral objectives according to Bloom's taxonomy (Remembering, Understanding, Applying, Analyzing, Synthesizing) using the following formula:

The map was prepared from the content of Chapter 4 covered in the research and its sections were distributed according to the study topics, as shown in Table (12).

Table (12): Test Specification Map for the Achievement Test.

Level / Content	Bloom's Levels							Total
	Remembering %45	Understanding %33	Applying %12	Analyzing %6	Synthesizing %4	Relative weight	Page No	
Chemical Reactions	2.25 ~ 2	1.65 ~ 2	0.6 ~ 1	0.3 ~ 0	0.2 ~ 0	25	5	5
Expression of Chemical Reactions	1.8 ~ 2	1.36 ~ 1	0.48 ~ 0	0.24 ~ 0	0.16 ~ 0	%20	4	3
Balancing Chemical Equations	2.25 ~ 2	1.65 ~ 2	0.6 ~ 1	0.3 ~ 0	0.2 ~ 0	%25	5	5
Chemistry in Our Life	2.7 ~ 3	2.04 ~ 2	0.66 ~ 1	0.72 ~ 1	0.24 ~ 0	%30	6	7
Total	9	7	3	1	0	100%	20	20

Formulation of Achievement Test Items

One of the conditions for formulating test items is to consider mental development, the type of objective, and time management. Accordingly, 20 multiple-choice items were formulated, each with four alternatives, one of which represents the correct answer. Students are to choose one correct answer, with one point awarded for a correct answer and zero points for an incorrect, unanswered, or double-answer question.

Validity of the Test

The validity of the test refers to measuring what it was designed to assess. The validity of the test was verified through the following methods:

Face Validity: This refers to the overall appearance of the tool or its external presentation in terms of (type of items, how they are formulated, and their clarity). The achievement test was presented to a group of experts and judges specializing in education, measurement, assessment, and teaching methods. It was approved with an 85% agreement rate according to Cooper's formula.

Content Validity: The test specification table serves as an indicator of content validity. This validity was achieved through the preparation of the test specification table for the achievement test.

Construct Validity: This refers to how well the test measures a psychological construct or hypothesis. Construct validity is ensured if the items of the achievement test are distinct and specific to the construct being measured.

Pilot Application

The pilot application was conducted in two phases:

First Pilot Test: The purpose was to assess the clarity of the items, instructions, the time it takes for students to answer, and any questions that arise about the test items. The test was applied to a preliminary sample of students from "Anas bin Malik Boys' Middle School." It was found that the items and instructions were clear, and the average time for test completion was calculated by averaging the time of the first three students and the last three students, resulting in an average response time of 30 minutes.

Second Pilot Test (Item Analysis): The aim of this test was to perform statistical analysis on the items to assess the difficulty and ease of the test items for the intended trait. This also helped in evaluating the effectiveness of incorrect alternatives in the multiple-choice test items. The test was applied to a sample of 200 students from "Maaz bin Jabal Boys' Middle School," "Al-Orkidia," and "Al-Zahawi Middle School," randomly selected from the Al-Karkh II

Education Directorate, with 50 students from each school. After correcting the items, the forms were ranked in descending order and divided into two groups: the upper and lower 27% of scores for each group.

Psychometric Properties Checked

Construct Validity

Item Difficulty and Ease: The difficulty index for the items ranged from (0.65 to 0.30), while the ease index ranged from (0.68 to 0.37). According to measurement experts, the acceptable range for the difficulty index is between 0.80% and 0.20%, and it was found that all the difficulty and ease indices were acceptable.

Item Discrimination Index: The item discrimination indices ranged between (0.74 to 0.26). According to measurement experts, an item is considered acceptable if its discrimination index is 0.20 or higher.

Effectiveness of Incorrect Alternatives: The effectiveness of the incorrect alternatives was calculated for the test items. The results from applying the effectiveness equation for the incorrect alternatives showed that all incorrect alternatives had a negative effectiveness value. This indicates that the incorrect alternatives confused the weaker students, which demonstrates the effectiveness of the incorrect alternatives in the achievement test.

Reliability of the Achievement Test

(Internal Consistency Method) (Kuder-Richardson Formula): The reliability was verified using the internal consistency method with the Kuder-Richardson Formula 20. A sample of 80 forms was taken for statistical analysis. The correlation coefficient was found to be 0.84, which is considered acceptable if it falls between 0.70 and 0.90.

Final Version of the Achievement Test

After ensuring the validity, reliability, and consistency of the test through statistical analysis of the items, the test is now ready for final application on the research sample students. The final version consists of 20 multiple-choice items, each with four alternatives, one of which is correct. The highest possible score is 20 points, the lowest is 0, and the hypothetical average score is 10.

The Results of Research

To verify the hypothesis that states: There is no statistically significant difference at the significance level ($\alpha \geq 0.05$) between the mean scores of the experimental group students who are taught using the (K.W.L) strategy and the mean scores of the control group students who are taught using the traditional method in the achievement test for the subject of Chemistry.

The t-test for two independent, equal samples was used to examine the differences between the mean values and standard deviations of the achievement scores for the research sample students in Chemistry, as shown in Table (13).

Table (13): Results of the t-test for the Research Samples in the Achievement Test for the Subject of Chemistry.

Group	No	Mean	Standard Deviation	Degree of Freedom	Calculated t-value		Statistical Significance ($\alpha = 0.05$)
					Calculated value	Tabulated value	
Experimental	30	32.10	4.96	58	4.12	2.00	Not statistically significant
Control	30	26.47	5.62				

The table shows that the experimental group outperformed the control group in the achievement test for Chemistry. The mean score of the experimental group was (32.10) with a standard deviation of (4.96), while the mean score of the control group was (26.47) with a standard deviation of (5.62). When

applying the t-test for two independent samples to the research groups, the results indicated a statistically significant difference between the achievement mean scores of the two groups in favor of the experimental group. The calculated t-value was (4.12), which is greater than the tabular t-value at the significance level of 0.05 with 58 degrees of freedom. This indicates that the experimental group, which is taught using the (K.W.L) strategy, outperformed the control group, which is taught using the traditional method, in the Chemistry achievement test. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted: "There is a statistically significant difference at the significance level ($0.05 \geq \alpha$) between the mean scores of the experimental group students who are taught using the (K.W.L) strategy and the mean scores of the control group students who are taught using the traditional method in the Chemistry achievement test".

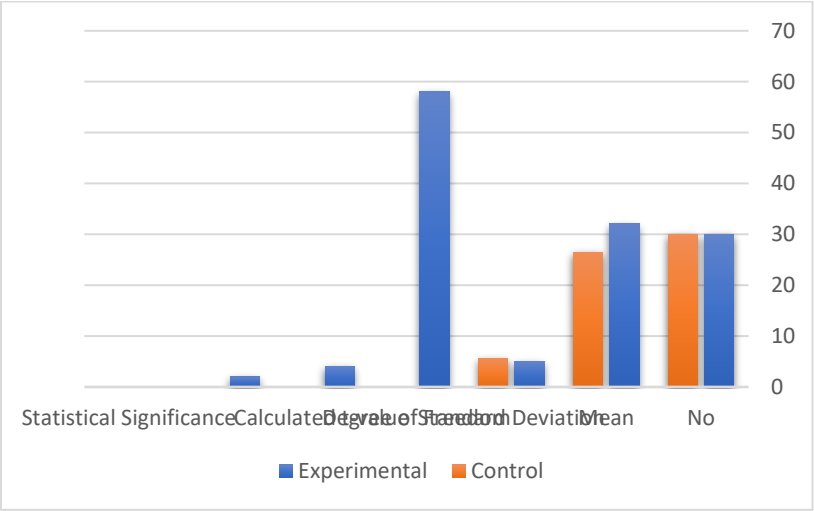

Figure (2): The differences in the mean scores of the research groups in the Chemistry achievement test.

It is evident from Figure (2) that the first-year middle school students in the experimental group outperformed those in the control group in the Chemistry achievement test.

Measurement of Effect Size: To determine the effect size of the independent variable (the strategy) on the dependent variable, academic achievement, for the students in the experimental group, the mean scores and standard deviations of the responses of the research groups were calculated for the post-test in Chemistry achievement, as shown in Table (14).

Table (14): Mean Scores and Standard Deviations of the Research Groups' Responses in the Post-test for Chemistry Achievement.

Test / Groups	No	Post -Test	
		Mean	Standard Deviation
Experimental	30	32.10	4.96
Control	30	26.47	5.62
Total	60	58.57	10.58

In order to verify the significance of the differences between the averages, one-way analysis of variance was used, and the results were as in Table (15).

Table (15): Results of the One - Way Analysis of Variance (ANOVA) for the Research Groups in the Post-test for Chemistry Achievement.

Variation	Sum of Squares	Degrees of Freedom	Mean Square	F – Vale		Significance Level	Sig
				Calculated	Tabulated		
Between Groups	476.017	1	476.0166	16.93628	4	0.05	Sig
Within Groups	1630.17	58	28.1063				
Total	2106.18	59					

Table (15) shows statistically significant differences at the 0.05 significance level in the post-test academic achievement in chemistry between the two research groups. The calculated F-value (16.93628) was greater than the tabulated F-value (4) at a degree of freedom (59-1). To determine the effect size of the independent variable on the dependent variable, Cohen's standard values were used, as shown in Table (16).

Table (16): Effect size values according to Cohen's classification and effect size.

Effect Size (D Value)	Magnitude of Effect
0,4 -0,2	Small
0,7 -0,4	Medium
0.8 and above	Large

(Cohen,1988: 273-279)

Table (17): Eta Squared Value and Effect Size Magnitude for the Post-Test Academic Achievement Variable of the Two Research Groups.

Independent Variable	Dependent Variable	Eta	Eta Squared	Effect Size
K.W.L Strategy	Academic Achievement	0.87	0.75	Large

Table (17) shows that The Eta Squared value is (0.75). When compared with Cohen's standard values for Eta Squared, it indicates that the effect size of the independent variable, which is the K.W.L strategy, on the dependent variable (academic achievement) was large. Cohen's effect size value was (1.63), indicating that the independent variable had a strong impact on the dependent variable (academic achievement) in favor of the experimental group.

"The results of this study, which indicate a positive effect of the K.W.L strategy on the academic achievement in chemistry among first-year intermediate students, are consistent with the findings of previous studies that have confirmed the effectiveness of active learning strategies in enhancing achievement. The researchers attribute this positive impact to several factors, primarily the focus of the K.W.L strategy on the learner as the central component of the educational process, in addition to the meticulous adherence to the strategy's steps and the active participation of students.

Furthermore, it is observed that the use of the K.W.L strategy contributes to providing an interactive and dynamic learning environment within the classroom. For instance, during the "What I Know?" phase, students demonstrated enthusiasm in sharing their prior knowledge, leading to rich discussions and the exchange of ideas. In the "What I Want to Know?" phase, their ability to pose in-depth and learning-objective-oriented questions increased, indicating the development of their critical thinking skills. In the "What I Learned?" phase, students became more proficient in summarizing information and connecting it to their existing knowledge, in addition to their ability to evaluate the extent to which their self-set learning objectives were achieved. Teachers can effectively implement this strategy by designing diverse classroom activities that include the use of K.W.L charts, encouraging group discussions, and providing continuous feedback to students. For example, the strategy can be used at the beginning of each unit to determine students' prior knowledge and establish learning objectives, and then used again at the end of the unit to assess what has been learned.

It should be taken into consideration that there are some limitations that may affect the generalizability of the results of this study:

- The study was limited to a small sample of first-year intermediate students in a single school, which may limit the generalizability of the results to a wider population.
- The study was conducted in a specific educational context, and the results may vary in other educational contexts with

different characteristics (such as private or public schools, or multicultural environments). Therefore, it is recommended that future studies be conducted on larger and more diverse samples, and in different educational contexts, to enhance the generalizability of the results.

The strategy contributed to broad educational effects that go beyond the positive effects of the K.W.L strategy merely improving academic achievement. It was observed that the strategy contributed to the development of students' higher-order thinking skills, such as critical thinking, problem-solving, and reflective thinking. It also enhanced students' motivation and interest in chemistry, as they became more engaged in the educational process and more willing to take responsibility for their learning. In addition, the strategy contributed to the promotion of active and cooperative learning, as students were given opportunities to interact with each other and exchange ideas and opinions."

Conclusions

Based on the research results, the following conclusions were reached:

Teaching using the K.W.L strategy contributed to increasing the academic achievement of the experimental group compared to the control group among first intermediate grade students.

Recommendations

1. Curriculum Developers: Systematically and explicitly integrate the principles and strategies of active learning, including the (K.W.L) strategy, into the science curricula for the intermediate stage. Provide guidelines and practical examples for teachers on how to effectively incorporate these strategies into their lesson plans.
2. School Administrators and Educational Supervisors: Organize continuous workshops and training courses for teachers on modern teaching strategies, with a particular focus on the (K.W.L) strategy and its application in teaching chemistry and other science subjects. These courses should include practical models and application activities to ensure teachers' deep understanding of how to use this strategy effectively.
3. Science Teachers: Adopt and implement the (K.W.L) strategy and other active learning strategies in teaching chemistry concepts and other science subjects. Teachers should educate students about the benefits of these strategies and encourage them to interact and participate actively in the learning process.

Suggestions

1. Conduct longitudinal studies to evaluate the long-term impact of using the (K.W.L) strategy on academic achievement and attitudes towards chemistry among students in different educational stages (such as preparatory and secondary level) .
2. Explore the effectiveness of the (K.W.L) strategy in diverse educational contexts, such as digital and online learning environments, and evaluate its impact on other skills such as reflective thinking and problem-solving among students.
3. Investigate the potential of integrating modern technologies, such as artificial intelligence, to support the implementation of the (K.W.L) strategy and provide personalized feedback to students, thereby enhancing the strategy's effectiveness and its impact on student learning.
4. Based on the findings of this study and future research, consider incorporating active learning strategies, such as (K.W.L), as a fundamental part of the adopted educational policies and practices in science teaching at various educational levels.

Disclosure Statement

- **Ethical approval and consent to participate:** The study was conducted with the approval of the school administration at Al-Saber Intermediate School for Boys / Directorate of Education – Baghdad. All procedures performed in the study were in accordance with institutional and ethical standards. Informed consent to participate was obtained from the school administration and teachers.
- **Availability of data and materials:** The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request. Due to the confidentiality of student information, some restrictions may apply to the availability of raw data.
- **Author contribution: Rusul Salam Jabbar** contributed to writing Chapter One, Chapter Two, full revisions, and formatting. **Damiaa Salim Dawood**: contributed to writing Chapter Three, Chapter Four, complete statistics, and journal correspondence.
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