

# Impact of Using Developed Learning Management System on Student's Scientific Thinking Skills: Applied Study on 10th Grade Chemistry Class

Ammar AL-Nawaiseh\* Prof. Mansour Alwraikat

School of Educational Science, Dept of curriculum and instruction, Jordan University, 2020.

## Abstract

This study aims at investigating the impact of activating Learning Management System (LMS) on students' scientific thinking skills in chemistry curriculum for a 10<sup>th</sup> grade class in Jordan. Researchers use a quasi-experimental approach on a random sample of (49) students separated into two groups; control by (23) students, and experimental by (26) students. The experiment involves the application of LMS to present and teach chemistry topics for the experimental sample, and to explain the same concepts in the traditional way of teaching for the control group. To measure the impact size, a test of scientific thinking skills developed and applied before and after the experiments. The results indicate that there are statistically significant differences in the level of students' scientific thinking skills in chemistry according to the method of teaching (LMS, and traditional) in favor of the experimental group. In addition, the study recommends the need to adopt the use of LMS in managing and teaching chemistry as part of national chemistry teaching standards.

**Keywords:** LMS; Scientific Thinking Skills; Chemistry for 10<sup>th</sup> grade; Jordan.

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## Introduction

The steady progress of technological development in education has led educators to employ the most effective teaching methods and tools for providing an interactive learning environment. Hence, students' scientific thinking has been always confirmed to be affected by the teaching method and tools used. Therefore, the evaluation and development of new initiative methods in teaching strategies based on digital context worth investigation. In this context, Learning Management System (LMS) supposed to enhance students' scientific skills in learning through the implementation of digital and multimedia elements, along with teacher's ability to synchronize and unsynchronized students' follow up. However, the educational level of the school has its own characteristics in terms of the grade and the way that students interact with technology.

Information and Communication Technology (ICT) has become effective tools for providing interactive learning environments for positive educational outcomes (Hilal, 2014). One of the most important aims of current educational policy is to provide an interactive, rich and multi-source learning environment through a rich digital environment, which leads to a sustainable development of information acquisition and comprehension (Zangour, 2014). However, involving e-learning activities can improve learners' scientific thinking to acquire knowledge and to spend more time looking for a better understanding of the underlined topics. Hence, educators and experts recommend paying more attention to LMS because of its effective role in supporting student's scientific thinking skills, and their achievements. They emphasize the steady transformation of some curricula and educational materials from its traditional presentation to an interactive electronic curriculum using LMS (Schlager and Derek, 2016; Lochner, Conrad and Graham, 2015)

Therefore, this paper investigates the efficacy of both teaching methods, the traditional method for control group and the method that is based on LMS for the experimental group in teaching current chemistry curriculum for 10<sup>th</sup> graders. LMS method has complex concepts and structures that require imagination and creativity thinking (Qudah, Al-Omari 2014). It investigates the use of current LMS in International Independent Schools (IIS), affiliated by Amman directorate of education, and verifies its impact on student's scientific thinking skills in learning chemistry. Thereof, the current study attempts to show the impact of communicating chemistry curriculum for 10<sup>th</sup> grade through a fully interactive electronic curriculum on student's scientific thinking skills using LMS.

## Literature Review

LMSs can be defined as integrated software designed for managing teaching and learning processes based on Information and Communication Technologies (ICT), including courses content, simultaneous and asynchronous communication tools, test management, assignments, courses enrollment, and student learning follow-up (Al-Ubaid, 2015). Therefore, LMS supposed to dynamically manage all learning activities, improve students' scientific thinking skills, and extend learning opportunities (McGill and Klobas, 2009). LMSs provide important service for content management, which remotely allows teachers to manage the content of a course through web application without having experience in web programming (Garrote and Pettersson, 2012). Teachers can create,

modify, publish, customize, and archive the course content (kohan, 2017).

E-learning management systems can be classified into two main categories. First, the open-source systems, which are free and customizable software offered for educational institutions, such as modules software. Second, the commercial LMSs which are commercial software that require a license to operate, such as the Blackboard system (Al-Bunyan, 2019). In addition, literature points that LMS is an open term and alternatively include the concepts of Content Management Systems (CMS), Learning Content Management System (LCMS), and e-Learning Platforms (Anshari et al,2016; Courts and Tucker, 2012).

Moreover, several learning theories actively align with electronic LMS and its ability to improve the educational process, to keep pace with technological developments, and to meet what the future school requires. For instance, the structural theory, which is one of the most important theories that is concerned with the cognitive structures of the learner's decision (Qarareh, 2012), argues that changes in the learner's cognitive capabilities come from linking the new knowledge with previous cognitive structures (Sawafta, Radwan, 2013). In addition, LMS supports the arguments of the communication theory, which relates effective learning outcomes to the quality of communications being adopted for utilizing interaction methods to convey ideas, information, concepts, customs, traditions and trends. Communication is an efficient tool for change, development, and interaction between individuals or groups (Al-Zahrani, 2014). Thus, LMS provides several communication patterns through which a synchronous or asynchronous interaction can be made between the student and the teacher, and the students themselves.

Scientific thinking skills have become the most important cognitive and educational psychology targets (Kuhn, 1988). They can be viewed as a type of thinking based on scientific methods or views, such as realism, natural, and experimental (Zimmerman, 2007). These skills can be improved based on the way that student practice in processing information and data to achieve various educational goals, ranging from memorizing information, describing objects, taking notes to predict objects, classifying objects, providing evidence, solving problems, and reaching conclusions (Sadah, 2015).

### **Problem Statement**

The quality of education, along with ICT developments, has become an important apprehension for educators to integrate learning and management as a response to digital changes and renewal strategies. LMS has been approved to solve communication problems faced by students, teachers, school, and parents because of its capabilities to effectively facilitate the learning process (Al-Hazani, 2012). Therefore, the application of e-learning in educational institutions requires a fully functional LMS system to ensure continuous communication among all parties of the educational system, to complete educational services and to give feedback for provided services. LMSs support electronic educational process, which includes academic and management follow-up of students (Al-Sharif, 2014). However, the researcher, who has a long experience as a school principal and a general manager of an international educational institution, which employs contemporary technological capabilities address the problem of study. The feedback reported from the field, in all cases, resulted from not activating available electronic services by students and teachers, which reflected negatively on students' scientific thinking skills, and their achievements. Hence, the need to adopt and to activate the services of an effective electronic LMS that meets the needs of students to improve their skills has become a demand for an investigation. Therefore, the study comes to experimentally fill the gap of using developed and fully utilized LMS by investigating the role of fully empowering LMS on scientific thinking skills for the chemistry curriculum of 10<sup>th</sup> grade students.

### **Aim and Objectives:**

The current study aims at addressing the impact of using LMS teaching method on students' scientific thinking skills. To achieve this aim, the researchers measure the impact of using electronic LMS as a teaching method on students' scientific thinking skills in chemistry curriculum for 10<sup>th</sup> grade students compared to traditional teaching classroom.

### **Study Significant**

The significance of the study lies on managing the use of most prominent techniques of LMS in chemistry teaching, which is characterized by its complex concepts that need assistive methods and models to improve students' scientific thinking to understand relationships, bonds, and chemical structures. This, in turn, leads to the practical importance of studying the impact of LMS and its contextual or exploratory contribution on education, which helps in overcoming a shortage of physical educational tools and resources; however, it is possible to exploit the proliferation of smart phones and available applications to use them in the classroom. Mainly, the concepts, procedures, and results of the study also help researchers to conduct more research and studies related to the application of LMS in various subjects, which in turn will provide recommendations to decision-makers to adopt those technological enhancements in the Jordanian school environment.

### Study Instrument and Method

This paper adopts a designed quasi-experimental research approach to examine the impact of LMS on students' scientific thinking skills in chemistry curriculum for 10<sup>th</sup> grade students. The study uses a measurement scale designed in a form of test for both experimental and control groups. This test applied before and after the implementation of LMS experiment for measuring student's scientific thinking skills in chemistry curriculum for the 10<sup>th</sup> grade class scores starts from 0 to 25. It contains 5 sections (Defining the problem, choose hypotheses, Hypothesis testing, Interpretation and Generalization) with 5 questions for each. Results of Pre and Post-measurements for the control and experimental groups supposed to draw the impact results of using LMS in teaching chemistry classes.

### Instrument validity and Reliability

To ensure the content validity of the study instrument that measures students' scientific thinking skills in chemistry curriculum for 10<sup>th</sup> grade students, the test was sent to a number of experts and arbitrators in educational science and curricula in Jordanian universities. Their comments were considered to delete, amend, and add some paragraphs to the scale until it was finally approved. As for instrument reliability, the researchers used the Split-Half method by splitting the scale questions into two even parts, so that the odd questions are the first part of the scale, and the even questions are the second part. Results of the Pearson coefficient between the two parts produced to find the coefficient of the whole scale, which indicated a high and acceptable reliability level ranged from (80.23 - 90.23). Moreover, in order to ensure the same experiment setting for control and experimental group before starting LMS classes, we applied t-test analysis to ensure that there are no statistical differences between both groups in their scientific thinking skills before conducting LMs experiment as shown in table (1).

Table (1): Independent Samples Test

	Group	Frequency	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Scientific Thinking Skills	Experimental	26	-0.192	47	0.848	-0.37793	1.96381	-4.32861	3.57276
	Control	23							

The results in table 1 do not indicate any statistical differences at the level ( $\alpha \leq 0.05$ ) in the scientific thinking skills for 10<sup>th</sup> grade students before exposing the experimental group to LMS class. This finding indicates the validity and reliability of our experiment setup.

### Study Hypothesis

The current study attempts to test the following null hypothesis:

**H<sub>0</sub>:** There are no statistically significant differences at the level ( $\alpha \leq 0.05$ ) in the development of scientific thinking skills for 10<sup>th</sup> grade students due to the method of teaching.

### Results

The current study aims at revealing the impact of applying LMS classes on the scientific thinking skills in teaching the chemistry curriculum for the 10<sup>th</sup> grade students. Therefore, this section presents the investigation result to the study hypothesis, which states "There are no statistically significant differences at the level ( $\alpha \leq 0.05$ ) in the development of scientific thinking skills for 10<sup>th</sup> grade students due to the method of teaching". Results of arithmetic means and the standard deviations of the two groups' performance are shown in table (2).

Table (2) scientific thinking skills the pre and posttests

Test	Group	Frequency	Pre-test		Post-test	
			Mean	St.D	Mean	St.D
Scientific Thinking Skills	Experimental	26	10.50	4.55	21.27	4.26
	Control	23	6.91	2.92	14.22	4.18
	Total	49	8.82	4.24	17.96	5.48

Table (2) shows an apparent difference between the arithmetic means between the scientific thinking skills in teaching the chemistry curriculum for the 10<sup>th</sup> grade students in the pre and post-tests according to the group. To determine whether the differences between the means are statistically significant at the level of ( $\alpha \leq 0.05$ ), ANCOVA test was applied as shown in Table (3).

Table (3): ANCOVA for scientific thinking skills of pre and posttests.

Source	Sum of squares	DF	Mean squares	F	Sig.	( $\eta^2$ ) ETA square
Scientific Thinking Skills	57.162	1	57.162	3.372	.073	.068
Teaching Method	363.216	1	363.216	21.424	.000*	.318
Error	779.867	46	16.954			
Adjusted total	1443.918	48				

\* Statistical significance at the level of ( $\alpha \leq 0.05$ ).

Table (3) shows that there are statistically significant differences at the level of ( $\alpha \leq 0.05$ ) between the performance of the 10<sup>th</sup> grade students on the level of scientific thinking skills according to the method of teaching (LMS or tradition). Therefore, we reject the null hypothesis and accept the alternative, which proposes statistically significant differences at the level ( $\alpha \leq 0.05$ ) in the development of scientific thinking skills for 10<sup>th</sup> grade students due to the method of teaching. Furthermore, we find the effect size by extracting the ETA square reached (0.318), which means that (31.8%) of the variance in v can be attributed to the teaching method. In addition, the result in table (4) determines the favor to which group these differences are belonging.

Table (4): Differences between the two groups.

Test	Group	Adjusted mean	Standard error
Scientific Thinking Skills	Experimental	20.79	.85
	Control	14.76	.91

Results in Table (4) shows that the experimental group maintains a higher arithmetic mean than that of the control group in terms of developing their scientific thinking skills.

### Discussion and Conclusion:

The previous sections showed the level of student's scientific thinking skills before and after adopting a developed version of LMS in teaching chemistry curriculum for the 10<sup>th</sup> grade. Students were initially tested against scientific thinking skills in both groups, control and experimental before activating LMS. Pretest results indicated a convergent level of scientific thinking for students in both groups, control and experimental groups with no statistical differences found. This enhances the validity of the experiment setup and ensures a similar condition for both groups. Afterwards, the developed version of LMS activated used and to teach a selected topic in the chemistry book for students in the experimental group; while students in control group studied the same topics by using the traditional method. Then, students into both groups were retested against their scientific thinking skills. Results of the posttest, after developing and activating the use of LMS, indicated a variance with statistically significant differences between the two groups. These differences can be attributed to the intervention of using LMS that students underwent in the experimental group. Students in an experimental group maintained an improved level of scientific thinking skills as a result of using different learning resources such as online course, presentations, multimedia-based activities, continues to follow up and free of time and place limitations. Moreover, LMS brings the opportunity for both teachers and students to overcome individual differences among various student groups by spending more time in an attractive learning environment.

### Recommendations:

Based on the promising results, the current study provides the following recommendations:

- 1- Adopting and implementing LMS in teaching chemistry curriculum and other science curricula.
- 2- Motivating teachers and students to activate and use LMS resources.
- 3- Conducting extended scientific research to verify the relevance of the curricula and their conformity with the requirements of the adopted LMS.

### References

- Anshari, M., Alas, Y., Hamid, M. H. S. A., & Smith, M. (2016). Learning management system 2.0: Higher education. In *Handbook of research on engaging digital natives in higher education settings* (pp. 265-279). IGI Global.
- Kuhn, D., Amsel, E., O'Loughlin, M., Schauble, L., Leadbeater, B., & Yotive, W. (1988). *The development of scientific thinking skills*. Academic Press.
- Zimmerman, C. (2007). The development of scientific thinking skills in elementary and middle school. *Developmental review*, 27(2), 172-223.
- Hilal, S. (2014). Electronic Learning management systems as a strategic solution to support the use of the interactive tablet and raise communication efficiency in the educational process. *Arab Society for Education Technology*. (13) 89-109.
- Zangur, S. (2014). An interactive educational site in the light of e-learning management systems and its impact on developing visual perception skills and information generation for high school primary students with learning

difficulties in mathematics. Kingdom of Saudi Arabia. *Journal of Mathematics Education* 17 (5) 6-130.

Schlager, D. (2016). Schoology: The Adoption of a Learning Management System.

Lochner, B., Conrad, R. M., & Graham, E. (2015). Secondary teachers' concerns in adopting learning management systems: A US perspective. *TechTrends*, 59(5), 62-70.

Qudah, N. & Al-Omari, M. (2014). The degree of using the E-Learning Management System (MOODLE) by Yarmouk University students and their attitudes towards it (Doctoral dissertation, Yarmouk University).

Eid, A. (2015). A proposed concept based on the use of cloud computing services as an e-learning management system in the university educational process. *Arab Studies in Education and Psychology*, 63 (1), 203-239.

McGill, T. J., & Klobas, J. E. (2009). A task–technology fit view of learning management system impact. *Computers and Education*, 52(2), 496-508.

Garrote, R. J., & Pettersson, T. (2012). The use of learning management systems: A longitudinal case study. *E-Learning and Education*, 1(8).

Kohan, B. (2017). What is a Content Management System (CMS)? Retrieved from <http://www.comentum.com/what-is-cms-content-management-system.html>.

Al-Bunyan, R. (2019). Assessing Umm Al-Qura University experience in using the Blackboard e-learning management system. *The Arab Journal for Educational and Psychological Sciences*, (8), 75-98.

Courts, B., & Tucker, J. (2012). Using technology to create A dynamic classroom experience. *Journal of College Teaching & Learning* (Online), 9(2), 121.

Qarareh, A. O. (2012). The Effect of Using the Learning Cycle Method in Teaching Science on the Educational Achievement of the Sixth Graders. *International Journal of Educational Sciences*, 4(2), 123-132.

Sawafta, W. (2014). The impact of the five-year learning strategy based on the electronic learning management system "Black Board" and an interactive software in physics achievement for engineering students at King Saud University. *Jordanian Journal of Educational Sciences*, 10 (2) 161-176.

Al-Zahrani, I. (2017). The effect of different communication style in e-learning management systems on the achievement of scientific concepts of educational technology for students of the Faculty of Education at Al-Baha University. *Journal of Faculty of Education*, 1 (8).

Saadeh, J. (2015). Thinking and Learning Skills. Dar Al-Masirah, Amman, p. 45.

Al-Hazani, N. (2012). A study to evaluate the quality of the Jusoor e-Learning Management System. *Studies in Curricula and Teaching Methods - Egypt*, (72) 109-159. **APPENDIX: Measurement Scale of Scientific Thinking Skills.**

**Section I: Identify the problem**

**Which of the following is more reflective of the problem in the previous text?**

- A. Low ozone concentration in the atmosphere.
- B. The arrival of ultraviolet radiation to the surface of the Earth.
- C. The increased incidence of cancer.
- D. The negative effect of low ozone concentration in the atmosphere.

The most expressive choice is:

Question	A	B	C	D
				√

**Start answering questions:**

1. The process of preserving elements and chemicals is one of the most important public safety standards in laboratories. Therefore, the element sodium should not be stored under water or outdoors due to its strong reaction with oxygen.

- **\*Which of the following is more reflective of the problem in the previous text:**

- A-Sodium is not preserved under water or outdoors due to its severe reaction with oxygen.
- B-Sodium shall be kept outdoors provided that there is no water.
- C-Sodium is kept under water provided that there is no oxygen.
- D-The importance of public safety standards.

2. Dry Lab software can be used to insure the safety of students inside laboratories because of the danger of dealing with some elements and chemicals on the one hand and the high prices on the other.

\* - **Which of the following is more reflective of the problem in the previous text:**

- A. Using dry laboratory software.
- B. The seriousness of dealing with some elements.
- C. High prices of elements and chemicals.
- D. The seriousness of dealing with some elements and high prices.

3. It is advised not to store foods in pots containing aluminum because of the interaction of aluminum with foods



and the formation of toxic substances

**\* Which of the following is more reflective of the problem in the previous text:**

- A. Not to keep food for a long time.
  - B. Keeping foods in containers containing aluminum is harmful and may lead to poisoning.
  - C. The reaction of aluminum with oxygen
  - D. The reaction of aluminum with oxygen is toxic.
1. The Aluminum element is widely used in industries, especially the manufacture of aircraft structures because it is resistant to rust and lightness, unlike iron element completely, but aluminum is more expensive than iron.

**\*Which of the following is more reflective of the problem in the previous text:**

- A. Aluminum is used in the manufacture of aircraft.
  - B. Aluminum is characterized by its resistance to rust and lightness, so it is used in the manufacture of aircraft structures.
  - C. Iron is not recommended for the manufacture of aircraft structures because it is heavy and rusted.
  - D. Although aluminum is rust-resistant and light, its price is high.
5. Metals are good conductors of electricity and heat, so copper is used in the manufacture of cables, but it is necessary to isolate the wires with insulation to maintain public safety.

**\*Which of the following is more reflective of the problem in the previous text**

- A. Metals are good heat conductors.
- B. Metals are good conductors of electricity.
- C. The importance of insulation of wires in order to maintain public safety.
- D. Copper is used in cable making and is inexpensive .

## Section 2: Choosing Assumptions (Solutions)

Instructions:

This section requires you to read the text before each question that is a specific problem and then identify the appropriate hypothesis that the text expresses. You choose an answer that expresses the hypothesis that you understand from four choices that exist after the question on the answer sheet.

**Example:**

A number of farmers noted that the reclamation and cultivation of land with sandy soil with wheat crop consumed twice the amount of water used to irrigate wheat in ordinary land.

**\* Which of the following is an appropriate imposition to express the solution of the previous problem?**

- A. The use of modern irrigation methods helps to retain water in sandy soils.
- B. The use of more water helps to grow wheat plant.
- C. The use of fertilizers helps to grow wheat plant better.
- D. The use of pesticides helps the wheat plant grow better

D	C	B	A	Question
			√	

6. Water has had a large share of pollution because of the poor use of natural water resources by humans by discharging the residues of factories containing toxic chemicals to all living organisms.

**\*Which of the following is a suitable imposition to express the solution of the previous problem?**

- A. Imposing strict penalties on factories that pollute water resources.
- B. Preventing the discharge of industrial waste into the water will reduce its pollution.
- C. Keeping factories away from water sources will reduce the problem.
- D. Treatment of toxic chemicals in water reduces the problem .

7- A number of farmers noted that the addition of fertilizer containing potassium, phosphorus and nitrogen to the soil increases its fertility and thus increases the yield.

**\* - Which of the following is an appropriate imposition to express the solution of the previous problem?**

- A. The use of triple fertilizer (NPK) leads to increased yield.
- B. The use of a larger amount of potassium element leads to increased yield.
- C. Using any three elements together will lead to increased yield.
- D. The addition of the element phosphorus with a large amount of water leads to increased yield.

8-Inhalation of bromine gas leads to infertility if repeated inhalation without regard to public safety requirements.

**\* - Which of the following is an appropriate imposition to express the solution of the previous problem?**

- A. To stop the use of bromine in laboratories and prohibit it internationally.
- B. Bromine substitution with any other element of the same group such as chlorine.
- C. Not to use bromine compounds for fear of the release of bromine gas.

- D. Develop policies and guidelines to deal with the risks of chemical elements and compounds.
- 9- Carbon dioxide emissions from factories are a threat to the environment and lead to general warming.  
 \* - **Which of the following is a suitable imposition to express the solution of the previous problem?**
- A. Non-use of carbon-containing compounds in industry.
  - B. Shut down factories, thereby ensuring that carbon dioxide is not emitted;
  - C. Treatment of carbon dioxide in the atmosphere and its conversion into other chemical compounds.
  - D. Dependence on renewable energy sources leads to reducing the problem.
10. Hydrogen is not recommended in balloons because of the risk of flammability.  
 \***Which of the following is a suitable imposition to express the solution of the previous problem?**
- A. Replacement of balloons and other tools.
  - B. The use of environmentally acceptable forms of technology;
  - C. Replacing hydrogen with helium.
  - D. Replacing hydrogen with oxygen.

### Section 3: Assumptions Test

Instructions: This section requires you to read the text before each question, which is a suggested hypothesis for a problem, and then determine how best to test the validity of the hypothesis and make sure it is correct. You choose an answer that expresses the best way to confirm the hypothesis that you understand from the four choices that exist after the question on the answer sheet.

#### Example:

Some recent studies suggest that the consumption of genetically modified plants that scientists enter by modifying some of their genes to improve them may increase the incidence of cancer in children.

**Which of the following is the best way to test the validity of the previous hypothesis?**

- A. Identify the causes of cancer in children as a result of consuming certain foods.
- B. Study the effect of modified genes on the incidence of cancer in children.
- C. Compare the incidence of cancer in two groups of children, the first consume natural plants and the second consume plants genetically modified.
- D. Prevent scientists from interfering with the modification of some genes in plants and study the impact on the low incidence of cancer in children.

The most expressive choice is:

D	C	B	A	Question
	√			

11 - Adding chlorine to the water leads to the killing of germs and microbes, so it is advisable to add chlorine to the swimming pools periodically within the permissible concentrations.

\* **Which of the following is the best way to test the validity of the hypothesis?**

- A. Know the properties of chlorine and its location in the periodic table.
- B. Determine the characteristics of germs and microbes.
- C. Determination of the pH of the water.
- D. Conducting laboratory experiments to determine the effect of adding chlorine to a water sample.

12- Some scientists reported that the elements of the same group are similar in characteristics, and are similar in the number of electrons of the last level.

**Which of the following is the best way to test the validity of the previous hypothesis?**

- A. An inventory of the characteristics of each element;
- B. Determine the valence electrons for each element.
- C. Determine the number of levels for each element.
- D. Compare the characteristics of the elements of the same group and relate this to the equivalence numbers.

13- Nitrogen is stabilized in the soil by bacteria found in the root nodes of some legume plants such as beans and lentils, so farmers grow legumes in the soil after planting wheat plants.

**Which of the following is the best way to test the validity of the previous hypothesis?**

- A. Identify the causes and importance of the presence of nitrogen in the soil.
- B. Conducting a study to identify the types of germs present in root nodes.
- C. Conducting a study to know the effect of introducing legume cultivation in the agricultural cycle, especially responsible for wheat cultivation.
- D. Comparison between wheat production in two soils has been cultivated by the first with tomatoes and the second with beans.

14- Scientific studies have confirmed the absence of pure water naturally and contain dissolved substances such as some minerals.

**Which of the following is the best way to test the validity of the previous hypothesis?**

- A. Add fluoride to water to detect dissolved substances.
- B. Add fluoride and chlorine together to detect dissolved substances.
- C. Water filtration and thus purification from dissolved substances and salts.
- D. Study the properties of dissolved oxygen to determine the usability of water.

15- Volcanic rocks give decomposed fertile soil suitable for cultivation because of its important mineral elements are diverse, so the plains of Horan important agricultural land.

**Which of the following is the best way to test the validity of the previous hypothesis?**

- A. Conducting chemical analysis of mineral elements in volcanic soil.
- B. Monitoring the production of agricultural crops between volcanic soils and sandy soils.
- C. Determine why the plains of Horan are important as fertile agricultural lands.
- D. Studying how volcanic rocks decompose into mineral elements .

#### Section IV: Interpretation

Instructions:

This section requires you to read the text before each question that is a problem and then determine the best explanation. You choose an answer that reflects the interpretation you chose from the four choices that exist after the question on the answer sheet.

Example:

The inhabitants of the cold areas where snow falls in large quantities of cracking and breaking plastic pipes outside the buildings, so the population works to cover them with heat-insulating materials.

**Which of the following is the best explanation for what was mentioned in the previous problem?**

- A. Materials in pipes do not withstand low temperatures.
- B. Plastic pipes cannot be used in cold areas.
- C. Materials in pipes need high temperatures.
- D. Insulating materials shall be used to prevent the freezing of materials in pipes.

**The most expressive choice is**

D	C	B	A	Question
√				

16- Experiments confirmed that the oil paintings turned dark over time and that there is a relationship between the lead element containing the colors and the hydrogen sulfide gas from the air.

**Which of the following is the best explanation for what was mentioned in the previous problem?**

- A. The color of lead is mixed with the color of hydrogen sulfide to form a dark color.
- B. Increasing the proportion of hydrogen sulfide in the atmosphere.
- C. the reaction of lead with hydrogen sulfide forming a dark substance.
- D. The reaction of lead with other gases such as oxygen to form a dark substance.

17. Iron reacts with water in the presence of oxygen to form iron rust, and uses paint to prevent or reduce this phenomenon.

**Which of the following is the best explanation for what was mentioned in the previous problem?**

- A. Iron is a substance that can react with oxygen.
- B. Iron must be replaced by another element to prevent rusting.
- C. Iron rust results from the length of time.
- D. The coating prevents oxygen and water from reaching the iron and thus does not corrode

18-Mercury is toxic and evaporates very quickly at room temperature, so it is placed next to Sulfur.

**Which of the following is the best explanation for what was mentioned in the previous problem?**

- A. Mercury is a highly toxic element.
- B. Mercury evaporates at high temperature at room temperature.
- C. Mercury evaporation should be prevented.
- D. Sulfur is used to submerge mercury and thus easily collect and reduce the risk of evaporation.

19- Some studies have shown the importance of the use of titanium in dental implants and artificial joints because of its unique characteristics.

**Which of the following is the best explanation for what was mentioned in the previous problem?**

- A. Because it is solid and maintains its durability at high temperatures.
- B. Because it is solid and low density.
- C. Because it is solid and high density.
- D. for its solidity, strength and fitness for the human body .

20- Copper is one of the most frequently used metals, most notably copper used in the manufacture of electrical cables.



**Which of the following is the best explanation for what was mentioned in the previous problem?**

- A. Copper is a metal.
- B. Copper is a transition element.
- C. Copper element has good heat conductivity.
- D. Copper has good electrical conductivity.

**Section V: Generalization**

Instructions:

This section requires you to read the text before each question and then choose an answer that expresses a generalization (general result) that you can extract from the text and apply in similar situations from the four choices that exist after the question on the answer sheet.

Example:

Illiteracy is an obstacle to the achievement of comprehensive development in society, and countries strive to combat it and provide programs and adopt projects to combat illiteracy, especially in the countryside.

**Which of the following is an appropriate generalization that can be drawn from the previous text?**

- A. Combating illiteracy shall ensure the social development of society.
- B. Literacy is a basic source of knowledge.
- C. Literacy is concentrated only in the countryside.
- D. Combating illiteracy requires programs and projects.

The most expressive choice is:

D	C	B	A	Question
		√		

21 - Metals are characterized as a good conductor of electricity and heat and copper metal, so copper is a good conductor of electricity and heat.

\* Which of the following is an appropriate generalization can be drawn from the previous text?

Metals are good conductors of electricity and heat.

Metals are malleable and non-retractable.

Copper is a good conductor of electricity.

copper is a good conductor of heat.

22 - Atomic volume increases as we move in the periodic table from top to bottom within a group.

**Which of the following is an appropriate generalization can be drawn from the previous text?**

- A. The atomic volume increases with increasing number of levels.
- B. Ionization energy increases with increasing number of levels.
- C. The atomic size increases with the number of electrons at the last level.
- D. The ionization energy increases with the number of electrons in the last level.

23- Electronic distribution of two groups of elements, one containing one electron at the last level and the other containing two electrons at the last level.

**Which of the following is an appropriate generalization can be drawn from the previous text?**

- A. The valence electrons (the last level) represent the group number in the periodic table.
- B. The valence electrons (last level) represent the period number in the periodic table
- C. The number of levels represents the number of the group in the periodic table.
- D. The number of levels represents the period number in the periodic table.

24- One of the students went to the laboratory and found a box with an unknown chemical, white in color, and similar to table sugar.

**Which of the following is an appropriate generalization can be drawn from the previous text?**

- A. No unknown substance may be used.
- B. The material must be tasted to know what it is.
- C. The material must be sniffed to see what it is.
- D. The material must be smiled, touched and tasted to see what it is.

25- Noble gases contain a level filled with electrons and therefore do not react.

**Which of the following is an appropriate generalization can be drawn from the previous text?**

- A. Each element containing a last full level is a noble gas.
- B. Noble gases contain eight electrons at the last level.
- C. Noble gases react only with elements of the first group.
- D. Inert gases react only with inert gases