Difficulties in Learning Scientific Concepts Challenges in Acquiring and Understanding Scientific Concepts

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Received: 07/01/2025 **Published: 05/05/2025**

Abstract:

The learning of scientific concepts holds great importance, as it helps learners enhance their understanding of scientific subjects, tackle problems, and reduces the need for relearning when faced with a similar new situation. Scientific concepts also play a role in organizing experiences, constructing principles and generalizations, as they represent the mental structures that assist learners in identifying relationships between various facts.

Learners, however, encounter difficulties in acquiring and properly understanding these scientific concepts due to several factors. These include inadequate teacher training, the nature of the concepts themselves, confusion between the concepts and their verbal meanings, a lack of prior knowledge about the new concept, and the absence of feedback for learners. Additionally, there are internal factors related to the learner, such as a lack of motivation and readiness to learn, as well as external factors like an unsuitable curriculum for the learners' level and the failure to employ appropriate teaching methods.

Keywords: The learning process, scientific concepts, difficulties in learning scientific concepts.

Introduction

Teaching scientific concepts is considered one of the contemporary approaches in science education. The focus on scientific concepts stems from their ability to provide meaning to scientific material, unlike other components of science such as facts, laws, and theories. Some recent studies highlight the significance of scientific concepts in the learner's cognitive structure, as concepts often become embedded in the learner's long-term memory, enabling

prolonged retention of scientific material (Al-Muhaysin, 2007, p. 117) Scientific concepts are also among the most crucial aspects of science learning due to their role in organizing experience, recalling knowledge, tracking mental representations, and linking them to their sources. Educators emphasize the need to develop scientific concepts, as they facilitate a clearer understanding of science for learners. The clarity of concepts and terminology is essential for comprehension, assimilation, and effective scientific communication. Additionally, the formation and development of scientific concepts among learners is a fundamental goal of science education across all age groups. These concepts form the foundation of science and scientific knowledge, aiding in understanding its overall structure and ensuring the transfer of learning. Therefore, forming or refining scientific concepts among learners of varying educational levels requires an appropriate teaching approach that ensures the proper development, retention, and sustainability of these concepts (Ishtaywi, 2018, p. 4).

Recent studies highlight the significance of scientific concepts in the learner's cognitive structure, as these concepts often become embedded in long-term memory, enabling prolonged retention of scientific material. Teaching concepts is considered a fundamental skill for every educator; when a learner truly grasps core concepts, their chances of success in later stages increase. Concept learning begins in early childhood, starting with a set of unstructured stimuli that gradually become organized, with classification and terminology serving as the primary methods for structuring concepts (Mansour, 2014, p. 97).

The present study aligns with the work of Zohair Mansour Al-Muzaidi (2012) on Concept Hunting, in which he elaborates on the nature of concepts, the fundamental stages of their formation, their characteristics, learning methods, and various related aspects.

Scientific concepts are among the most critical outcomes of science, as they serve as the organizing elements and guiding principles for any acquired scientific knowledge, whether in the classroom or other learning environments. Science education has long emphasized the importance of learning scientific concepts and guiding their acquisition appropriately. Due to the diverse roles, characteristics, complexities, acquisition processes, structures, and sources of scientific concepts, challenges in their learning and development have become evident. Consequently, ensuring that learners acquire scientific concepts has become a primary educational goal, carefully considered in curriculum design across different educational stages.

Research in science education has identified several difficulties associated with learning scientific concepts, including: The inherent nature of scientific concepts, particularly their complexity, level of abstraction, and sensitivity to perception. Confusion between a concept's meaning or verbal designation and non-scientific terminology. Mixing up similar or opposing concepts in terms of wording. A lack of prior knowledge necessary for understanding new concepts. Insufficient feedback and inadequate time for identifying mistakes and corrections. Internal learner-related factors, such as lack of readiness, motivation, and interest in learning. External factors, including reliance on unsuitable curricula and teaching strategies, as well as low teacher motivation and insufficient training (Al-Zoubi, 2016, pp. 66-67). Thus, the current study examines the issue of difficulties in learning scientific concepts, aiming to establish a theoretical foundation by analyzing, categorizing, and reviewing research findings on this topic. Given the significant importance of learning scientific concepts and the numerous challenges faced by educators, particularly in academic settings at various levels, the study seeks to address key questions.

- What are these difficulties?
- How are they classified?
- What are their characteristics and sources?
- what factors influence concept Learning ?

1. Definition of Scientific Concepts

Scientific concepts have been defined in multiple ways, including:

- Bolton (1977) defined them as: "A logical organization of experiences and facts derived through an understanding of the relationships among them, which can be assigned a name." (Al-Hashemi, 2013, p. 37).
- Abu Saleh (1995) described them as: "An abstract representation of shared properties among a set of objects or elements, expressed through a word, term, or symbol." (Al-Hashemi, 2013, p. 38).
- Zeitoun (2001) defined them as: "The meaning and understanding an individual develops in association with a word, phrase, or specific process." (Al-Hashemi, 2013, p. 39).

Despite the variations in definitions, scientific concepts are generally viewed as terms encompassing a set of generalized ideas derived from specific events, observations, or situations. They are cognitive constructs that emerge from recognizing relationships or shared attributes among phenomena, occurrences, or objects. Research literature also indicates that a scientific concept is an abstraction of common elements among multiple entities, which is then assigned a name, symbol, title, or term (Zaitoun, 2007, p. 481).

Scientific concepts serve as the foundational building blocks of science and can be examined from two perspectives:

1.1. The Scientific Concept as a Process

It is a mental process through which a set of shared attributes, observations, or facts related to an object, event, or process—or a group of objects, events, or processes—is abstracted.

1.1.1. The Scientific Concept as a Product of This Mental Process

It refers to the name, term, or symbol assigned to the set of shared attributes or characteristics.

A. Examples of Scientific Concepts

Names: Light, digestion.

Terms: Chromosome, electron.

Symbols: Na, DNA (Al-Khazraji, 2011, p. 27).

From the above, despite the diversity and abundance of definitions for scientific concepts, they can generally be defined as a broad mental representation of shared attributes among objects. These concepts can be expressed through a word, multiple words, or specific symbols. Scientific concepts serve as the fundamental building blocks of science. Examples of such concepts include photosynthesis, respiration, and mammals.

2. Classification of Scientific Concepts

Scientific concepts can be classified into several categories.

2.1. Based on How Concepts Are Perceived

2.1.1. Concrete Concepts

These are concepts whose meanings can be perceived through direct observation using the senses or sensory aids, Examples

– Concept: Atmosphere → Meaning: The layer of air surrounding the Earth.

– Concept: Cat → Meaning: A mammal covered in fur, which nurses its young and belongs to the felid family.

2.1.2. Abstract Concepts

These are concepts whose meanings cannot be directly observed and require mental processes and cognitive interpretations for comprehension Example.

– Concept: Photosynthesis → Meaning: The process by which plants and algae produce food and release oxygen.

2.2. Based on Their Levels

2.2.1. Primitive Concepts

These concepts cannot be derived from other concepts: Time, mass.

2.2.2. Derived Concepts

These are concepts that can be formulated based on other concepts: Distance = Speed × Time. (Awadallah, 2012, pp. 36-37).

2.3. Based on Their Level of Complexity

2.3.1. Simple Concepts

These are concepts whose meanings are conveyed using only a few words Examples:

- Cell: The basic unit of a living organism.
- Ion: An atom or group of atoms carrying an electric charge.

2.3.2. Complex Concepts

These are concepts that require a more detailed explanation involving multiple words Example:

- Atom: A structured system of particles, where negatively charged electrons revolve in energy levels around a nucleus that contains most of the atom's mass. The nucleus consists of two types of particles: one carrying a positive charge and the other neutral. The number of positive charges equals the number of negative charges.

The complexity of a concept varies from one academic level to another, depending on the learner's linguistic and cognitive development.

2.4. Based on Their Ease of Learning

2.4.1. Easily Learnable Concepts

These are concepts that are defined using words familiar to learners or concepts for which learners have already studied the prerequisites.

2.4.2. Difficult-to-Learn Concepts

These are concepts that are defined using words unfamiliar to learners or concepts for which learners have not yet studied the prerequisites. (Abbas, 2016, p. 33).

3. Characteristics of Scientific Concepts

It is evident that a concept is not merely a set of associative relationships formed through memory or a simple mental habit. Instead, it is a complex and dynamic process that cannot be learned solely through training but rather emerges when the learner's cognitive development reaches the necessary level. Some defining characteristics of a concept, which provide a clear indication of its nature and how it develops in learners' minds, include:

- Concepts are the primary tools of thought.
- Science progresses with the development of concepts.
- Schools play a crucial role in shaping concepts.
- Concepts are generated through experience, and without experience, they remain incomplete.

– Concepts depend on learners' prior experiences. (Mansour, 2014, p. 95).

– A scientific concept does not refer to a specific individual or a particular part but rather to a general category to which individuals or elements belong.

– A scientific concept consists of two parts: the name, symbol, or term (e.g., cell, matter, Earth) and its verbal meaning (e.g., matter is anything that occupies space and has weight and can be perceived by the senses).

– Scientific concepts are initially formed and built through three main processes: differentiation, organization (classification), and generalization.

– The formation and development of scientific concepts is a continuous process that progresses in complexity from one educational level to another. (Zaitoun, 2007, pp. 481-482).

– Scientific concepts are more stable and enduring than scientific facts, as facts can be subject to modification and change.

– A scientific concept involves the principle of generalization, meaning it does not apply to a specific object or situation but rather to a group of entities, such as the concepts of matter, animal, or plant.

– Each scientific concept has distinguishing characteristics that set it apart from others; for example, the concept of a flower differs from that of a fruit, and the concept of reptiles differs from that of amphibians.

– The number of distinctive attributes of a concept varies from one concept to another. For instance, saying "the apple fruit is yellow" identifies two properties—texture and color—whereas saying "the small yellow apple fruit" adds a third attribute, which is size. (Al-Hashemi, 2013, p. 49).

Additionally, the characteristics of scientific concepts have been defined as follows:

– Concepts are summaries and outcomes of human experiences with objects or phenomena and facilitate dealing with various facts.

– Example: Through sensory experiences, humans observe that dogs give birth and nurse their young, as do cats and rabbits. From these observations, they derive the concept of mammals.

– Concepts can result from abstract thinking (i.e., they are not limited to sensory experience alone), and this abstract thinking may itself be derived from direct experience.

– Example: Humans observed the line spectra of sodium vapor and iron, leading to the conclusion that electrons orbit the nucleus in discrete energy levels, thus forming the concept of energy levels.

– Concepts may emerge from the relationship between facts, and larger concepts may arise from the relationships between multiple concepts, forming what is known as a conceptual framework.

– The meanings of concepts are not photographic representations of reality; rather, they reflect our perception or interpretation of it.

– Example: The atomic structure concept.

– Not all conceptual meanings correspond to a physical reality; sometimes, scientists create new concepts to bridge the gap between reality and our understanding of it.

– Example: The concept of "positive holes" in semiconductors.

– The meanings of concepts are neither true nor false; rather, they may be sufficient or insufficient for performing their functions. Their validity cannot be definitively proven or disproven, but their reliability can be assessed.

– Example: Dalton's concept of the atom was sufficient to explain the phenomena known in his time, and we do not say it was false.

– The meanings of concepts are subject to revision and modification due to the advancement of scientific knowledge and the development of scientific tools. (Al-Isaawi, 2008, pp. 40-39).

Based on the aforementioned points, the key characteristics of scientific concepts can be summarized as follows:

– Concepts grow and evolve continuously.

– Concepts progress from complexity to simplicity and from ambiguity to clarity.

– The development of concepts in learners is influenced by several factors: age, experience, and environment.

– Concepts form the fundamental structure of knowledge.

– A concept consists of an idea or a set of mental ideas.

4. Factors Affecting the Learning of Scientific Concepts

In general, there are four factors that influence the learning of scientific concepts

4.1. Type of Concept

4.1.1. Tangible material concepts

These are concepts derived from and linked to physical actions or direct experiences. They are represented using familiar terms and are formed during the stage of concrete operations.

4.1.2. Abstract concepts

These concepts are formed by identifying a set of shared attributes and are assigned a name or term through indirect observation, based on the relationships the learner perceives in the concept.

Learning material concepts (e.g., pen, car, book) is easier than learning abstract concepts (e.g., democracy, faith, justice), which may require long periods for the learner to gradually transition from ambiguity to full clarity in understanding the concept.

4.2. Examples of the Concept

Presenting examples, whether positive or negative, helps clarify and define the concept being learned. Positive examples represent the concept and fit all of its characteristics, while negative examples do not represent the concept and do not match all of its key features.

4.3. The Learner's Prior Experiences

Prior experiences are an important factor in learning concepts. The learner's understanding of the concept is connected to their understanding of previous knowledge requirements. This is because concepts are interconnected hierarchically or in a cumulative structure, where both sequential and continuous processes are involved.

4.4. The Learner's Age

Presenting concepts to a primary school learner differs from presenting them to a middle or high school learner, both in terms of quantity and quality. (Al-Samarrai, 2014, pp. 33-43).

5. Difficulties in Learning Scientific Concepts

Learning scientific knowledge is not without difficulties, whether related to the nature of scientific knowledge itself, the method of its presentation, or the level of understanding and comprehension of the person presenting it. Scientific concepts vary in types, simplicity, and complexity, and this variation affects learning. Some of the difficulties include:

– The Nature of the Scientific Concept: This refers to how well the learner understands abstract or complex scientific concepts, such as the concepts of: nutrition, nutrients, reproduction, etc.

– Confusion in the Meaning of Concepts: This is related to the misinterpretation of the meaning or the verbal significance of certain scientific terms, especially those used as technical terms, such as: metabolism, ecological balance, etc.

– Lack of Scientific Background of the Learner: For example, when a learner studies the concept of evaporation, learning this scientific concept depends on some prior scientific concepts such as: heat, liquid state, gaseous state, and natural changes.

– Difficulty in Learning Previous Scientific Concepts Necessary for Learning New Concepts. (Boujemaa, 2012, p. 67).

– Shared Characteristics Among Different Scientific Terms.

– Failure to Apply the Scientific Term in New Scientific Situations.

– Confusion Between Opposite Scientific Terms, such as: oxidation/reduction.

– Rushing to Generalize, for example: considering every animal with wings as a bird.

– One Activity Containing Several Scientific Terms with Different Meanings. (Ambousadi, 2009, p. 206).

– The Term Has No Meaning in the Language in Which the Learner Is Learning, such as: enzyme proteins.

– Failure to Relate the Scientific Term to the Learner's Environment.

– The Teacher's Lack of Understanding of the Scientific Term.

– Difficulty in Pronouncing the Scientific Concept, such as: actinomycetes.

– Few Supporting Tools to Help Clarify the Concept.

– Failure to Arabize Some Terms, such as: dynamic equilibrium.

– The Length of the Scientific Concept's Word, such as: glucocorticoids.

And Khataiba adds the following difficulties:

– Teaching strategies used in concept instruction.

– Internal factors of the learner, including the learner's readiness, motivation for learning, interest, and inclination toward scientific subjects, as well as the environment in which they live.

– Inappropriate scientific curricula.

– Science teachers themselves, in terms of their teaching methods, competencies, and their understanding of scientific concepts. (Mansour, 2014, pp. 104-105).

In conclusion, the difficulties in learning scientific concepts can be summarized as follows:

5.1. Difficulties related to the concept itself its verbal meaning or characteristics

Scientific concepts vary; some are simple, easy, and clear because they are tangible, while others are complex and difficult because they are intangible or abstract. Here are some examples for clarification:

5.1.1. Easy concepts

These include material concepts (perceptions of objects that can be grasped through the senses). They have shape and size and can be described, such as living organisms: cow, rabbit, fruit trees, forest trees, etc.; parts of animals or plants: heart, lung, intestines, leaf, bud, root, etc.; or substances: blood, milk, sap, etc.

5.1.2. Intermediate concepts

These can be sensed and seen but are not entirely subject to our senses, such as stars, Earth, the Sun, the Moon, wind, light, etc.

5.1.3. Difficult concepts

This category includes all intangible concepts, such as relational concepts (e.g., molecular weight), process concepts (e.g., digestion), classification concepts (e.g., genus), and affective concepts (e.g., objectivity). It also includes

microscopic materials, such as atoms, electrons, ions, molecules, enzymes, nerve impulses, genes, etc.

5.2. Difficulties related to the learner

such as the learner's scientific background, prior knowledge, or perceptions of the concept, as well as individual differences among learners.

The development and growth of concepts in an individual progress from simple to complex, from one lesson to another, and from one stage to the next. A learner who possesses correct prior simple concepts can effectively learn new concepts, whereas one who lacks them will struggle to do so. The lack of scientific background is considered the second major obstacle in learning scientific concepts.

This deficiency may be due to the following factors:

– Failure to learn previous concepts: The learner has never encountered them due to incomplete coursework, absence, or other reasons.

– Difficulty in learning previous concepts: Concepts were presented theoretically (or through unsuccessful practical methods), preventing their proper consolidation in the learner's mind.

If the learner struggles to grasp previous concepts, they will find it even more difficult to learn new ones, especially if the teacher does not recognize this and does not attempt to correct misunderstandings before introducing new material. (Baji, 2015, pp. 81-82).

To clarify, consider the following examples:

– The concept of genetic expression: This concept will not be properly established in learners' minds if previous concepts are missing, such as chromosomes, genes, nucleotides, genetic code, enzymes and their functions, phenotype, etc.

– The concept of digestion: This concept will not be properly formed unless the preceding concepts are present and correctly understood, including the digestive system and its accessories, nutrients, enzymes, etc.

– Lack of the learner's cultural background: If a learner does not engage in scientific reading, does not discuss or ask questions, is passive in their learning, lacks interest in natural sciences as a whole or in a specific teaching unit, and relies solely on what the teacher presents, they are unlikely to acquire scientific concepts correctly. This makes them not much different from an illiterate person or someone outside the field of study. The lack of an appropriate cultural background necessary for acquiring correct concepts is further exacerbated by the influence of unregulated mass culture (absence of a structured scientific educational policy in the media and society, often replaced by myths).

Some concepts are deeply rooted in learners' minds but in a simplified or incorrect manner due to their acquisition from colloquial language (mass culture), and they remain unchallenged by either the teacher or the learner during the learning process. Examples include the heart as the "organ of love," the liver as the "center of compassion," microbes as "harmful organisms," humans as "rational animals," blood pressure, cholesterol, diabetes, madness, earthquakes, nerves, and more.

Rule: Learning new scientific concepts depends on prior scientific concepts.

Scientific concepts are like a building; constructing a second floor is impossible if the first floor does not exist or is too weak to support it. Science is built cumulatively, and the principle of constructivism in learning must be respected.

5.3. Other Difficulties

– Difficulties related to curricula, teaching methods, and strategies used by teachers.

– Difficulties related to the surrounding environment: Cultural, social, customs, and traditions.

6. Sources of Difficulties in Learning Scientific Concepts

Educational literature states that these difficulties mostly arise from external factors beyond the learner’s control. Among these difficulties are:

6.1. Inappropriate Curricula:

This includes the following :

– Curricular content that does not adequately consider learners' prior knowledge.

– Concepts within the curriculum that may not align with the actual levels of learners.

– Inclusion of scientific activities that most learners may struggle to perform.

– Expectations from officials, teachers, and parents that learners will acquire a large number of scientific concepts quickly, even when they are not yet ready for them, leading to the perception that "science curricula are unsuitable."

Science curricula may be adopted from Western (foreign) models without considering cultural differences or available material and technical resources.

6.2. Linguistic Factors or Language of Instruction

The language of instruction (Arabic) is considered an external factor that affects learners' understanding of scientific concepts, especially when learners are taught in a language different from their mother tongue, such as English or

French, as is the case in some Arab countries. Additionally, the dialects used by teachers also influence the formation or comprehension of scientific concepts among learners.

6.3. Teaching Methods

Traditional teaching methods, such as lectures, recitations, presentations, and explanations, affect the formation and understanding of scientific concepts among learners. When learners do not learn effectively, it is often due to the contribution of inappropriate teaching methods.

6.4. Science Teachers Themselves

This factor is related to the teaching methods and strategies applied by teachers in their classroom and laboratory practices. In addition to the aforementioned factors, it can also stem from other aspects related to the teachers themselves.

– Teachers' qualifications below the required level.

– The extent to which teachers themselves understand the scientific concepts.

– The extent to which internal incentives are available to the teacher, and the teacher's motivation and connection to the teaching profession.

As for the internal factors contributing to the formation of difficulties in learning scientific concepts among learners - and according to various researchers - they are as follows:

– The extent of the learner's readiness and motivation for learning in general, and for learning scientific concepts in particular.

– The extent of the learner's interest and inclination towards scientific subjects and learning their concepts.

– The environment in which the learner lives, which may not encourage or may obscure the spirit of inquiry and scientific investigation. (Zeitoun, 2005, pp. 82-83).

Conclusion

The process of learning concepts is a cumulative process of construction. It is not only about adding new information to the learner's previous knowledge, but it aims to create an interaction between previous scientific knowledge and new scientific knowledge. To ensure this interaction, the new knowledge must be understandable and comprehensible. Therefore, the teacher must consider two important aspects for the learners: previous knowledge and the characteristics of new knowledge. Given the importance of concepts in teaching scientific concepts, it is crucial for the learner to have correct scientific concepts that help them understand the scientific material and move from primitive knowledge to correct and advanced knowledge, free from misconceptions or alternative conceptions.

Educators emphasize the importance of scientific concepts, as they facilitate the learners' understanding of science clearly. The clarity of concepts and terms is essential for understanding, comprehension, and achieving scientific communication. Despite the importance of learning scientific concepts in building knowledge, there are difficulties that stand in the way of acquiring correct scientific knowledge. From this standpoint, studying scientific concepts, understanding their characteristics, the pedagogical methods of forming them, and the difficulties faced by both teachers and learners in teaching and learning them are objectives at all levels of education.

Bibliography

1. Abbas, Z. A.-A. (2016). The Effect of Using Educational Films on the Development of Certain Scientific Concepts Among Kindergarten Children Aged 5–6 Years. Master's Thesis. Syria: Faculty of Education, Tishreen University.
2. Al-Hashemi, A. R. (2013). Classroom Activities and Scientific Concepts (1st Edition ed.). Amman, Jordan: Ghaidaa Publishing and Distribution.
3. Al-Isaawi, T. I. (2008). The Effect of the V-Shape Constructivist Strategy on Acquiring Scientific Concepts and Scientific Processes Among Seventh-Grade Students in Gaza. Curriculum and Teaching Methods. Gaza, Palestine: The Islamic University.
4. Al-Khazraji, S. I. (2011). Contemporary Methods in Science Teaching (1st Edition ed.). Amman, Jordan: Osama Publishing and Distribution House.
5. Al-Muhaysin, I. b. (2007). Teaching Science, Rooting and Modernization (2nd edition ed.). Riyadh, Kingdom of Saudi Arabia: Al-Obikan Library.
6. Al-Samarrai, Q. M.-K. (2014). Modern Trends in Teaching Methods (1st Edition ed.). Jordan: Dar Dijlah Publishers and Distributors.
7. Al-Zoubi, T. M. (2016). Science Teachers' Methods in Addressing the Difficulties of Learning Scientific Concepts Among Basic Stage Students in Light of Strategic Teaching Principles. The Islamic University Journal for Educational and Psychological Studies, 24(02).
8. Ambousadi, A. a.-B. (2009). Methods of Teaching Science: Concepts and Practical Applications (1st Edition ed.). Amman, Jordan: Dar Al-Masirah.
9. Awadallah, M. M. (2012). The Effect of the Five E's Strategy on the Development of Scientific Concepts and Science Learning Processes Among Seventh-Grade Female Students in Gaza. Master's Thesis. Palestine: Faculty of Education, Islamic University of Gaza.

10. Baji, B. (2015). Teaching Natural Sciences. Old Al-Quba, Algeria: Higher School for Teachers.

11. Boujemaa, S. (2012). Teaching and Learning Scientific Concepts: The Subject of Natural and Life Sciences as a Model. Journal of Humanities and Social Sciences(08).

12. Ishtaywi, A. &. (2018). The Effect of Using Two Augmented Reality Modes on the Development of Scientific Concepts and Scientific Sense in the Science Subject for Seventh-Grade Female Students. A research paper submitted for a Master's degree. Gaza, Palestine: Faculty of Education, Islamic University.

13. Mansour, M. (2014). The Importance of Scientific Concepts in Science Teaching and the Difficulties of Learning Them. Journal of Studies and Social Research(08).

14. Zaitoun, A. M. (2007). Constructivist Theory and Science Teaching Strategies (1st Edition ed.). Amman, Jordan: Dar Al-Shorouk for Publishing and Distribution.

15. Zeitoun, A. M. (2005). Teaching Methods in Science (1st Edition ed.). Amman, Jordan: Dar Al-Shorouk for Publishing and Distribution.