

*A proposed unit in the light of the Standards of life Applications of Chemistry Formulated by the (4MAT) Model of McCarthy for Second Year Secondary School students and its Impact on the Development of their Attitude Towards the Study of Chemistry*

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**Abstract**

**T**he purpose of the study was to build a proposed unit in the light of the standards of life applications of chemistry formulated by the (4MAT) model of McCarthy for second year secondary school students to measure its impact on the development of their attitude towards the study of chemistry. To achieve this, a list of standards of life applications of the content of chemistry curriculum at the secondary school level was prepared. The "Industrial Chemistry" unit was prepared in the light of the list of standards formulated according to the McCarthy (4MAT) model. Instrument of the study is the scale of the attitudes towards studying chemistry. Participants (27 girls) were selected from 2nd year secondary school students in Beni Mazar. The semi-experimental one-group design was used to measure the effect of the independent variable "Industrial Chemistry" Unit in the light of the standards of life applications of the chemistry curriculum formulated according to the McCarthy (4MAT) model on the attitudes towards the study of chemistry. The results of the study indicated that there was a statistically significant difference between the mean scores of the participants in the pre-post application in favor of post-application of the scale of the attitudes towards studying chemistry.

**Key words:** Proposed unit - Standards - Life applications of chemistry - The attitudes towards the study of chemistry.

**Introduction:**

The contemporary world is witnessing amazing and rapid scientific developments in various fields related to all aspects of daily life. This scientific development has led to the necessity of curriculum designers, especially chemistry curriculum, to pay attention to anything new and modern that benefits the learner both in increasing his scientific knowledge and in his daily life.

Chemistry is the center of basic science that constitutes the mainstay of modern life because of its impact on many requirements of life. So, lack of awareness of the importance and benefits of this science and its applications indicates the absence of a large role of educational institutions and the lack of academic integration of their programs, Chemistry science is based on experience and the output of laboratory work because it is an experimental science, as it is one of the constantly evolving sciences to meet the requirements of different life aspects throughout the ages by providing solutions to many problems with their interpretation (Odaisan Abu Abdoun, 2002, 1).

Qatar's Chemistry Content Standards (Education Authority, 2004), the Standard Levels Document for Science Content for Pre-University Education (National Authority for Quality Assurance and Accreditation, 2009), and international standards emphasize the importance of life chemistry applications as these documents contain many standards and indicators that are concerned with Life applications of this science.

Among the teaching paradigms emanating from structural theory, the 4MAT model emerged as a theory in cognitive learning when Bernice McCarthy proposed a form that is based on two tracks, the first track represents the perception of experience and the second track represents the handling of experience, where learners differ in the handling experience. Some like to relate it to their previous experiences and add to new experiences their feelings, while others like to move directly from direct experience to abstraction, and some others like to justify the new experience and see its interpretation (McCarthy et al, 2002,18, Amal Ayyash & Amal Zahran, 2013, 167 ).

Experts in science learning and teaching see that the formation and development of scientific attitude among students is one of the main goals of science teaching, This may be due to the role of scientific trends as directives for reliable behavior in predicting the type of scientific behavior of the individual, and considering them the motives that direct the student to Science methods, processes, and skills using a science methodology in research and thinking Thus, it is necessary in forming the scientific mindset since scientific thinking cannot be straightforward without it, (Ayesh Zaitoun, 2010, 139).

It is clear from the foregoing the importance of linking chemistry with its life applications, and the necessity of inserting it in the curricula of chemistry at the secondary stage in the light of the normative levels of the content of chemistry. Because of the entry of chemistry in all aspects of life, everything around us has a link to chemistry and its scientific and technological applications, and this may lead to developing students' attitudes towards studying chemistry.

### **Statement of the problem:**

Through his work as a teacher of chemistry, the researcher noticed difficulties of secondary school students in understanding chemistry, and this is consistent with what some studies such as (Osama Ahmed, 2008) , (Mahmoud Abu Naji, 2008, 168) and (Fatima Al-Amouriya, 2011, 112). They indicated that there are difficulties in high school students understanding of chemistry, due to the stiffness of chemistry as it is not related to their lives and the absence of the functional role of chemistry in life, which eventually leads to the automatic memorization of information without understanding it in order to pass the final exams at the end of the school year, and this affects their achievement and their attitude towards studying chemistry. Pan hurst's (2003) study indicated the low level of the attitude towards studying chemistry during learning chemistry as one of the basic building blocks that contribute considering it the basic element that prepares the individual for the world of industry and production. The researcher also conducted a diagnostic test to identify the extent of students' knowledge in the life applications of chemistry, the results of which indicated that students had little knowledge of some applications related to the chemistry curriculum.

### **To encounter this problem, the researcher answered the following questions:-**

- 1) What are the standards and indicators of life applications of the content of the chemistry curriculum for secondary school students?
- 2) What is the form of a proposed unit of study in chemistry in light of the standards of life applications for the content of the chemistry curriculum for second year secondary school students formulated by the (4 MAT) model for McCarthy?

- 3) What is the effect of the proposed unit on developing the attitude towards studying chemistry of second year secondary students?

**Aims of the study:-**

The study aimed at identifying the following: -

- 1) Standards and indicators of life applications of chemistry curriculum content of secondary school students.
- 2) Formulating a suggested unit of study in light of the standards of life applications of the content of the chemistry curriculum based on the McCarthy (4MAT) model of second-year secondary school students.
- 3) Knowing the effect of the proposed academic unit on developing the attitude towards studying chemistry of second year secondary school students.

**Importance of the study:-**

This study can contribute in:

- 1) Providing a list of standards and indicators of life applications of the content of the chemistry curriculum, which will be used by curriculum designers in developing secondary school chemistry curriculum.
- 2) Providing a suggested unit in light of the standards of life applications of the chemistry curriculum formulated according to the McCarthy (4MAT) model, which may benefit teachers in inserting life applications in the teaching of chemistry, and benefiting students from them in their daily life.
- 3) Provide a scale of the attitude towards studying chemistry; this may benefit teachers in measuring the attitudes of their students towards studying chemistry.

**Terminology of study:-**

**1- Life applications of Chemistry:-**

Operationally, defined as: the scientific and technological applications of the content of the chemistry curriculum at the secondary stage, which relate to many aspects of life and has an impact on the life of the individual and the society through the individual's practice in solving a problem or accomplishing a

work or discovering new uses for it that have been reached to in the light of life application standards of the content of the chemistry curriculum.

### **2-Life Applications Standards:**

Operationally, defined as: Terms describing the knowledge that a secondary school student must get about the scientific and technological applications of life aspects of the content of the chemistry curriculum for the secondary stage level.

### **3- McCarthy's 4MAT Model**

Operationally, defined as: A set of structured procedures that are used to teach a proposed unit in life applications of the content of the chemistry curriculum of the study group according to the stages developed by McCarthy that integrate experience with self, formation of the concept, practical experience, and self-discovery.

### **4-The attitude towards studying chemistry**

Operationally, defined as: a state of mental readiness towards the study of chemistry, which is represented in the feeling of the importance of studying chemistry, its enjoyment, and the attitude towards the chemistry teacher, and the life applications of chemistry through the scores obtained by the secondary school student in the scale prepared for that.

### **Sample of the Study:-**

Participants were chosen from the second year secondary school students for Girls in Bani Mazar. They were (27) female students.

### **Study Design:-**

- 1) The descriptive approach was used in the current study, which was to look through the standards of chemistry curricula in some Arab and foreign countries, and some international projects in the field of chemistry curriculum in order to prepare a list of standards and indicators of life applications for the content of the chemistry curriculum of the secondary stage.
- 2) The semi-experimental one-group design was used to measure the effect of the independent variable "Industrial

Chemistry" Unit in light of the standards of life applications of the chemistry curriculum formulated according to the McCarthy (4MAT) model" on the "the attitude towards the study of chemistry".

### **Instruments of the study:-**

- 1) A List of standards and indicators of life applications of the content of chemistry curriculum at the secondary level.
- 2) The unit "Industrial Chemistry" in light of the standards of life applications formulated according to the McCarthy (4MAT) model
- 3) The scale of the attitude towards the study of chemistry.

### **Hypothesis of the study: -**

The study seeks to verifying the following hypothesis:

There is a statistically significant difference at the level of significance ( $\leq 0.05$ ) between the mean scores of the study group that studied the proposed unit in chemistry in light of life applications using the (4MAT) model in the application (pre-post) of the attitude scale towards studying chemistry in favor of post-application.

### **Theoretical background and previous literature**

#### **The life applications of chemistry:**

Chemistry, as one of the natural sciences, plays a fundamental role in a person's life. It is included in his food, clothing, medicine, and many changes that surround him or her induced by them or naturally. Knowing how chemistry works will give a greater awareness of the complex processes behind some of the simplest things.

James j.Gallagher (2000, 311) notes that practical applications are the simple part of applications that receives little attention, although connecting abstract ideas to the real world is most important to understanding and applying scientific concepts. The learning process is most useful when we deal with applications and familiar experiences in students 'lives as the basics of applying abstract concepts to a deep understanding of the phenomena surrounding them.

Thus, the teacher's responsibility increases towards trying to reconcile the feeling of the importance of scientific applications with the availability of scientific foundations for these applications and answering students' questions (Why do we need to study this information?) (Abdullah Al-Anwar, 2003, 788-789). The goal of the chemistry curriculum is not only to learn chemistry, but to learn through chemistry, and it is important to link chemistry applications with adolescent lifestyle (Nogozi & Norman, 2006, 18).

Many Arab countries are concerned with applied chemistry through holding conferences, including: Qatar, which hosted the Pure and Applied Chemistry Conference in 2012, and the Fifth International Conference on Advanced Chemistry and Applied Chemistry, organized by the National Research Center from 21 to 23 October 2014, was held in Egypt. The first conference of applied chemistry was held in Jeddah from 18-19 November 2015.

Some studies also focused on life applications in science and chemistry curricula such as the study of (Mc Cormach & Steve, 2004), (Maryam Al-Shabibi, 2006), (Osama Ahmed, 2008) and (Amani Al-Ghamdi & Ibrahim Refaat, 2017).

### **Standards of life applications**

The Standards Movement is one of the most prominent recent trends that have spread strongly in recent times, and has been accepted and interacted by specialists in the field of education worldwide, until it became the feature of the era, which is almost called "the decade of standards" (Kamal Zaitoun, 2004, 115).

The normative levels emphasize the learner's acquisition of basic scientific concepts as a major goal of scientific education at all educational levels, as they benefit in understanding structure of the learning, and it also provides the learner with meaningful educational situations that help him make daily decisions and manage his various life matters, and enables him to follow the innovations in Science (Lisel Trowbridge & others, 2004, 114).

Many countries, whether developed or developing, were keen to keep pace with science education programs with international standards for science education in order to meet the national

competition with other countries in the scientific and technological field, and to ensure the ability of science students to absorb the scientific application of scientific knowledge in light of the rapid scientific development.

Some standards indicated that the content in any field of study should relate to the environment, society, and technology surrounding the learner and address the content to the personal and social dimensions of the learner's life (Ministry of Education, Volume I, 2003, 198), (National Authority for Quality Assurance and Accreditation of Education, 2009, 20 ).

It is clear from the above that: -

- Attention to include life applications in chemistry curricula improves students' attitudes toward chemistry and their acceptance of studying it.
- Developing chemistry should be done in the light of the standard levels of chemistry.

### **The (4 MAT) model for McCarthy**

McCarthy developed a 4Mode Application Techniques in the light of human development theories of John Dewey, David Kolp, Carl Jung and research left and right hemispheres-based learning research (Mc carthy. B,2002,1.18 Germain.C & Lippitt.L). McCarthy also notes that the theories of human development of John Dewey, Carl Jung and David Kolp formed the theoretical philosophy of the form system (4MAT) which assumes that the basis of human learning is nothing but a process of continuous personal adaptation resulting from his construction of the meanings in his life, and a model (4MAT) on the basis that the individual has a set of biological characteristics and evolutionary characteristics that are unique to each student, and these characteristics affect how the individual learns new information and skills, and that if conditions are designed a way that promotes the centers of power in the learning of each student, the quality of learning will improve (Liana Jaber & Maha Qaraan 2004, 16).

McCarthy believes that there are four types of learners according to the nature of their learning (Mc carthy. B, 1990,32)

and (Liana Jaber & Maha Quraan, 2004, 37) they are the (imaginative, analytical, logical, dynamic) learner.

(Khalil Youssef, Abdul Latif Hussein, 295-297) and (Amal Ayash & Amal Zahran, 2013, 168-169) indicate that McCarthy's model consists of four stages: - Reflective Observation - Concepts Formation - active experimentation - Concrete Experience.

Several studies indicated the effectiveness of the 4MAT form in achieving many goals in teaching science and its branches such as developing academic achievement and the direction towards science such as the study of (Delaney ,2002), (Amal Ayesh& Amal Zahran, 2013) and (Abdel Salam Al-Adil, 2017).

It is clear from the above that: -

The McCarthy (4MAT) Model is one of the latest educational strategies that support brain-based learning, and helps to consider the individual differences of students and take into account each student's learning style.

### **The attitude towards studying chemistry:**

The attitude is defined as: the relatively stable general feeling of a person who determines his response to a specific topic or issue in terms of acceptance or rejection (Ahmad Al-Najdi et al., 2002, 89).

Attitudes play a major role in a person's life as a motive and a guide for his behavior in different areas of his life, and attitudes have an important role in learning, as the positive attitude towards a specific subject is easy to learn, while the negative attitude towards the subject hinders his progress in learning in addition to the fact that individuals who have positive attitudes towards a specific subject have their performance In this topic, it is better than that of individuals with negative attitudes toward the same topic (Akubuiro & Joshua, 2004).

Several studies are concerned with developing the attitude towards chemistry, such as the study of (Effat El-Tanawi, 2001) which indicated the development of secondary school students 'attitudes towards some global issues arising from the interaction between chemistry, technology and society, and the study of (Osama Ahmed, 2009) which leads to the development of students' attitude towards chemistry applications; while

(Kubiatko, Milan, 2015) concluded that students have a positive attitude towards chemistry and no significant differences emerged between males and females.

### **Study procedures:-**

#### **First: Preparing a list of standards for life applications of the content of the chemistry curriculum of the three years at the secondary stage:**

A list of standards of life applications of the content of the chemistry curriculum of the three years in the secondary stage has been prepared by the looking through some local, Arab and international projects that dealt with preparing standards of the content of the chemistry curriculum of the secondary stage, and presented the list in its initial form to a group of jury members and make adjustments to formulate some indicators according to them comments And their observations, and their comments on the final form of the list of standards included a number (9) standards for the content of the chemistry syllabus that includes (78) indicators.

#### **Second: Preparation of a proposed unit in light of the standards of life applications:-**

##### **Preparing the "Industrial Chemistry" unit for the second secondary year**

The unit "Industrial Chemistry" was chosen in the light of standards and indicators of life applications, and it deals with a number of indicators listed within the standard "Know the role of chemistry in industrial processes".

The unit "Industrial Chemistry" was prepared, it included (the student's handbook and the teacher's guide) by defining the philosophy on which the unit was built, where the unit was built in the light of the standard levels of chemistry content and in light of the theoretical philosophy of the (4mat) model of McCarthy, then preparing a map of the proposed study unit, and preparing the student's handbook that includes six topics (ammonia industry - nitric acid - sulfuric acid - limestone - cement industry - soap industry and industrial detergents), specifying teaching, learning activities and methods of evaluation, then preparing a teacher's guide explaining how to teach the chemistry unit Using (4MAT) model of McCarthy .

**The final form of the student's handbook and teacher's guide: -**

The student handbook and the teacher's guide were presented to a group of jury members from the professors of curricula and methods of teaching sciences, and professors from the Faculty of Sciences specialized in chemistry and modifications were made in the light of their views, and the student handbook and the teacher's guide in their final form became valid for use.

**Third: Preparing a scale of the attitude towards studying chemistry.**

The scale consists in its initial form of (48) phrases distributed on four dimensions:(The importance of studying chemistry, enjoyment of studying chemistry, the attitude towards the chemistry teacher, the attitude towards life applications of chemistry) and it is divided into (26) positive phrase and (22) negative phrases In front of each phrase there are five alternatives that are (strongly agree, agree, not sure, disagree, strongly disagree), where each positive phrase is given weights (5, 4, 3, 2, 1) respectively for the alternatives, while negative phrases are completed Correct them in the opposite way, thus the highest grade was expected to be obtained by the student is (240), the lowest grade is (48) and the theoretical mean of scale is (144).

**Validity and Reliability of scale:**

The scale was presented to a group of jury members specialized in curricula and teaching methods to give their opinion, and to make the necessary modifications were made according to their opinions. The reliability of the scale was also calculated using the Alpha Cronbach method and it was found to be equal to (0. 85). This indicates that the scale is highly reliable and can be applied to the study group.

**Validate the internal consistency of the scale:**

The validity of the internal consistency of the scale was calculated by calculating the correlation coefficients between the score of each dimension of the scale and the total score of the scale. The results were as follows:

**Table (1)**  
**The values of correlation coefficients between the scale grades in each dimension and the total scale of the scale**

Dimensions	Correlation	significance	Type of significance
The importance of studying chemistry	0.819	0.01	Statistically significant
<b>enjoyment of studying chemistry</b>	0.882	0.01	
attitude towards the chemistry teacher	0.717	0.01	
The attitude towards life applications	0.773	0.01	

It is clear from the above table that the values of correlation coefficients of the four dimensions are statistically significant at (0.01) and this indicates that the scale has a high consistency in its phrases and its applicability to the study group.

### **Final form of scale:**

After modifying the scale, it became suitable for application to the study group. Table (2) shows the specifications of the scale.

**Table (2)**  
**The specifications of the scale of attitude for chemistry**

No	Dimensions	positive phrases	Total of positive phrase	negative phrases	Total of negative phrase	Total	Relative weight
1	The importance of studying chemistry	1,2,3,18,19,35	6	4,17,20,29,34,36	6	12	25%
2	<b>enjoyment of studying chemistry</b>	6,7,8,21,23,39	6	5,11,22,24,38,40	6	12	25%
3	attitude towards the chemistry teacher	10,12,14,26,28,30,43	7	9,13,25,42,44	5	12	25%
4	The attitude towards life applications	15,31,33,37,41,46,48	7	16,27,32,45,47	5	12	25%
<b>Total</b>			26		22	48	100%

### **Time to apply a scale of attitude toward the study of chemistry**

The time of application of the scale was (30) minutes, including the time of reading the instructions of the scale.

**The results:-****Results of applying a scale of the attitude towards the study of chemistry**

To test the validity of the hypothesis which states that there is a statistically significant difference at the level of significance ( $\leq 0.05$ ) between the mean scores of the study group that studied the proposed unit in chemistry in light of life applications using the (4 MAT) model in the application of (pre-post) scale of the attitude towards studying chemistry in favor of post application.

To test this hypothesis the value (t. test) for two samples was calculated to find out the significance of the difference between the mean scores of the two groups and the results are presented as in Table (3):

**Table (3)**

**The significance of the differences between the mean scores of the study group in the pre and post Applications of the scale of the attitude towards the study of chemistry (n = 27)**

Dimensions	Application	N	Mean	Standard deviation	t-value	df	Sig	Type of significance
The importance of studying chemistry	Pre test	27	44.78	5.38	3.98	26	0.001	significant
	Post test	27	48.44	6.98				
enjoyment of studying chemistry	Pre test	27	37.19	7.24	2.43	26	0.02	significant
	Post test	27	40.78	8.23				
attitude towards the chemistry teacher	Pre test	27	36.48	7.66	2.68	26	0.013	significant
	Post test	27	41.59	10.33				
The attitude towards life applications	Pre test	27	43.07	6.80	3.14	26	0.01	significant
	Post test	27	46.26	6.74				
The scale as a whole	Pre test	27	159.33	19.89	4.66	27	0.001	significant
	Post test	27	177.66	24.96				

It is clear from the table (3) that:

For the scale as a whole: the mean score of female students (study group) in the pre- application of the test is (159.33), while the mean scores of the post- application (177,66), and the value

of (t) is (4,66) is statistically significant At the significance level (0.01), that is, there is a statistically significant difference between the mean scores of the members of the study group in pre-post application and in favor of post-application in the scale of the attitude towards studying chemistry.

From the foregoing results it is clear that there are statistically significant differences in the scale of the attitude towards studying chemistry as a whole, and in all its dimensions (the importance of studying chemistry, enjoying studying chemistry, the attitude towards the chemistry teacher, the attitude towards the life applications of chemistry) in the pre and post application in favor of post-application.

Therefore, the hypothesis of the study is accepted, which means that the level of the (study group) attitude towards the study of chemistry in post- application is higher than that of pre-application.

The results of this study are consistent with the results of some studies that are concerned with developing the attitude towards chemistry, such as the study of (Effat Al-Tanawi, 2001), (Maryam Al-Shabibi, 2006), (Osama Ahmed, 2009), (Mohsen Farraj& Hebat Allah Mukhtar, 2009) and (Kubiatko, Milan, 2015).

#### • The impact of the unit on the attitude of female students towards studying chemistry:

To know the size of the unit's effect on female students 'attitudes toward studying chemistry, Cohen's equation (d) was calculated to find the size of the effect.

**Table (4)**

**The size of the unit's influence on female students 'attitudes toward chemistry**

	Value (d)	Effect size
The scale as a whole	0.89	great

It is clear from table (4) that the value of (d) Cohen for the scale as a whole is equal to (0, 89). Referring to the size of the effect extracted by the "d" indicator, it was found that the effect of the independent variable (unit of study) on the dependent variable (the attitude towards studying chemistry) is great.

**Discussion of the results:**

The results of the study indicated that there is a statistically significant difference in the pre-post application of the scale of the attitude towards studying chemistry, and this may be due to the following reasons: -

- 1) The topics of the proposed unit are related to the environment and the lives of female students, as knowledge and concepts were presented in a functional framework linking the concepts and their life applications, which increased the students' knowledge of the importance of chemistry and its life applications and thus led to the growth of their attitudes towards the study of chemistry. This is consistent with studies that indicated the effectiveness of using the applied approach in the growth of attitudes towards the study of chemistry, such as the study of (Maryam Al-Shabibi, 2006) , (Osama Ahmed, 2008) and (Kubiatko, Milan, 2015).
- 2) Performing some experiments in a practical way, such as the effect of sulfuric acid on sugar, the experience of making soap may have a role in developing the students' attitude towards studying chemistry.
- 3) Using the model of (4MAT) according to their learning styles in teaching the proposed unit, allows the student to move from one stage to another in a continuous and coherent manner, and to have a role in developing the students' attitude towards studying chemistry and this is consistent with the findings of the study of (Amal Ayyash & Amal Zahran, 2013).

**Study recommendations:**

In light of the results of this study, the following is recommended:

- 1) The development of chemistry curricula for the three years in the secondary stage in the light of standards and indicators of life applications of the content of the chemistry curriculum.
- 2) Development of teaching strategies used with students in teaching chemistry, which are based on brain-based learning, such as the McCarthy (4 MAT) model.
- 3) Emphasis on the application aspects of the content of the chemistry curriculum so that each concept is linked to what is related to life applications or the surrounding environment.

**Suggested Research:**

- 1) Evaluating science curricula in the light of standards and indicators of life applications of the content of science subject in the basic education stage.
- 2) The effectiveness of the McCarthy (4MAT) Model in teaching chemistry to develop other variables such as innovative thinking, scientific tendencies, and motivation for achievement.

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