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Students' Attitude towards Learning Chemistry

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Students Attitude Toward Learning Chemistry

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Abstract:
Students' attitude to learn chemistry is a complex construct. Developing positive attitudes towards learning chemistry in particular, is one of the key goals for teaching and learning sciences. In this work, we made an attempt to identify factors that could positively influence the attitudes towards learning chemistry of a sample of 103 students (boys and girls) of 10^{th} grade, from five randomly selected private secondary schools in Jerusalem. Based on existing theoretical frameworks, the assessment tool was developed and tested for validity and reliability. Necessary data were collected and analyzed by calculating the means, standard deviations, and simple percentages. The results, showed negative attitudes of students towards the subject were due to inadequate teachers' approach to the material, and poor non-formal instructional materials. Moreover, the study showed no attitude differences related to gender.
Some useful recommendations were profound in designing new curricula to guide and improve students' attitudes towards the study of chemistry.

Keywords: Chemistry, Attitude, non-formal educational material

ملخص:
إن طبيعة اتجاهات الطلبة نحو تعلم الكيمياء معقدة، وأن تطوير اتجاهات إيجابية نحو تعلم الكيمياء خاصة من الأهداف الرئيسة لتعليم العلوم وتعلمها. في هذه الدراسة تتبعنا العوامل التي تؤثر ايجاباً على اتجاهات عينة قوامها (103) طلاب (ذكر وانثى) من طلبة الصف العاشر في خمس مدارس من مدارس القدس الخاصة نحو تعلم الكيمياء.
ارتكازاً على الأدب التربوي في هذا الموضوع، طور الباحث استبانة اتجاهات نحو تعلم الكيمياء ، وبعد التأكد من صدق أداة القياس وثباتها، جمعت البيانات اللازمة، وحللت باستخراج الأوساط الحسابية والانحراف المعياري والنسب.
أظهرت النتائج أن اتجاهات الطلبة نحو دراسة الكيمياء كانت سلبية ، وأن من أسباب هذه الاتجاهات؛ عدم ملاءمة أسلوب المعلم في شرح المادة العلمية، وضعف الأساليب اللامنهجية في تعليم الكيمياء. كما أظهرت الدراسة أنه لا يوجد اختلاف بين اتجاهات الإناث والذكور نحو تعلم الكيمياء.
وأوصت الدراسة بالاهتمام بتصميم المناهج الجديدة، والتركيز على الأساليب اللامنهجية في التعليم من أجل تحسين اتجاهات الطلبة نحو دراسة الكيمياء.

Introduction:

Chemistry is an important branch of science taught in the Senior Secondary Schools; it enables students to understand what happens in the world they live in and how it contributes to the quality of life on our planet (Ware, 2001). Chemistry curricula commonly incorporate many abstract concepts, which are central to further learning in both chemistry and other sciences (Taber, 2002). Chemistry topics are generally related to or based on the structure of matter, and proved to be a difficult subject for many students (Sirhan, 2007).
Attitude, motivation, and genuine interest are the most important student characteristics associated with successful studies (Dalgety et al., 2003), (Berg, 2005b).
Attitude towards chemistry is essential; it denotes interests or feelings towards studying chemistry. Attitude and academic achievement are important outcomes of science education in secondary schools. Students' attitude and interest could play substantial role in students decision to study science (Abulude, 2009).

Students' attitudes towards learning chemistry fueled many study projects for a long time; in the late 1980s there was a significant decline in chemistry education, and towards the turn of the century, the issue of attitudes towards an interest in chemistry became an international concern; Recent publications presented a gloomy picture regarding students' ignorance in chemistry, and decline in enrollment in science-based careers (Hofstein & Naaman, 2011). Small percentage of students (about 4%) expressed the wish to study chemistry at the university level (Salta, 2004). Cheung (2009) mentioned in his thorough and comprehensive review of the literature that he found over the years, only nine studies (until the year 2009) that examined students' attitudes towards chemistry taught in secondary schools.

Questions about attitude have been investigated by many educational researchers; Shwartz (2006) mentioned that attitude to learn chemistry benefits all young students by fostering their chemical perceptive, which is the capability to recognize chemical concepts, define some key-concepts, identify important scientific questions, use their understanding of chemical concepts to explain phenomena, use their knowledge in chemistry to read a short article, or analyze information provided in commercial ads or internet resources. Oskamp and Schultz (2005) defined attitude as a predisposition to respond in a favorable or unfavorable manner with respect to a given attitude object. Yara's (2009) definition of attitude in science (chemistry) however, focuses on scientific approach assumed by an individual for solving problems, assessing ideas and making decisions. He

added, it is students' beliefs and attitudes that have the potential to either facilitate or inhibit learning.

Many factors could contribute to student's attitude towards studying chemistry such as; age, career interest, social view of science & scientists, social implications of chemistry or cognitive styles of students.

Salta and Koulougliotis (2011) identified the factors that could positively influence students' attitude to learn chemistry; these factors could be organized into three main categories:

- Teaching approaches,
- Educational tools,
- Non-formal educational material and activities.

Hence, For enhancing attitudes to learning chemistry (Hofstein & Naaman , 2001) suggested three key factors that should be considered : (i) the methods used to present the content (e.g. relevance, and historical approach), (ii) instructional techniques that are implanted, and (iii) gender issues.

In Palestine there has been, so far, no systematic study which aimed directly at measuring students' attitude towards learning chemistry. The focus of this paper is to study factors such as teacher influence, non-formal educational materials, and gender that might be affecting the attitudes of 10^{th} grade students towards learning chemistry, and before that, is to measure the students appreciation of chemistry.

Sirhan's study (2007) revealed that there is a negative attitude regarding the usefulness of the chemistry courses for the students future career, and a neutral attitude regarding the interest in the chemistry course it self.

Science teachers bear on their shoulders a huge responsibility of promoting and developing students' positive attitudes regarding science as a school subject (Abulude, 2009). There is a relationship between attitude and methods of instruction, and also between attitude and achievement; and that it is possible to predict achievement from attitude scores reported Adesoji (2008), and Popoola (2008).

An important factor is the non-formal ways of chemistry approaches. Non-formal education is the ground in the theory and practice of some of great educational thinkers of our time including Paolo Freire, Howard Gardner, David Kolb,

Malcolm Knowles and Bernice McCarthy (Corps, 2004). It is defined as an organized and sustained educational activates that do not correspond exactly to definition of formal education (UNESCO, 1997). It focuses on practical skills, intentional and systematic educational enterprise (usually outside of traditional schooling) in which content is adapted to the unique needs of the students (or unique situations) in order to maximize learning and minimize other elements which often occupy formal school teachers (Etllng, 1998) .

Surveys conducted in Europe (Osborne and Dillon, 2008) among large groups of young students clearly showed that girls and boys differ in their interest in science-related topics.
A study guided by Chang (et al, 2009) indicated that boys showed higher learning interests in sustainability issues and scientific topics than girls. This is in line with the previous studies by Morgil and Seçken (2004). However, girls recalled more life experiences about science and technology in life than boys.

Studies (Jegede, 2007) related to probing students' attitudes toward chemistry, indicated a low level of student motivation to engage in chemistry learning, a fact which could be related to the following issues:

- The unpopular ways of teaching which does not promote higher order cognitive, lead to gaps between students' wishes and teachers' teaching.
- Difficulty of the chemistry course.
- Wide coverage of the syllabus in combination with little allocated teaching time.
- Use of unattractive teaching methods.
- Low awareness of career opportunities.
- Lack of teaching aids / laboratory
- Attitudes of peers towards science (chemistry)
- Enjoyment of science (chemistry)
- The nature of the classroom learning environment
- Achievement in science and fear of failure in taking a science (chemistry) course
- Preference of learning approaches (pedagogy)-subject preference courses

Holbrook (2005) argued that current chemistry curricula approaches are not providing the impetus to promote the popularization of chemistry that is expected, they emphasize the developing conceptual understanding in students, forgetting the

appreciation of the way scientists do things, which makes chemistry irrelevant to student's life.

Purpose of the study

This paper aimed at studying factors such as teacher influence, non-formal educational materials, and gender that might be affecting the students' attitudes towards learning chemistry. The results could influence educators to enhance students' positive attitudes towards learning chemistry.

Study questions

The purpose was to answer the following questions:

1. Do students have positive attitudes towards chemistry?
2. Are students' attitudes towards chemistry a result of their teachers' approach?
3. Are students' attitudes towards chemistry a result of the non-formal educational materials?
4. Are there gender differences in students' attitudes toward chemistry?

Methodology

Study Population

The study population consisted of all 10^{th} grade students in five private schools in Jerusalem which totaled (103) student (49 boys and 53 girls). The study sample was chosen from accessible population of Jerusalem private schools, using a sample of convenience and limited to the academic year 2011/2012.

Study Instrument

In this study, a questionnaire was designed to assess the attitudes of students towards learning chemistry. It addressed the role of the teacher approaching the material, and non-formal educational materials used.

The questionnaire was based on the questionnaire by (Mackenzie et al., 2003; Ozden, Mustafa, 2007), which was developed and translated to Arabic (Appendix I). A plot survey was first carried out, and then the main questionnaire was structured.

The instrument was divided into two sections. Section A consisted of the bio-data of the students, while section B consisted of 30 questions on students' likeness of teachers' ways of approaching chemistry, and non-formal educational materials.

Section B was designed according to the standard Likert five-level: Strongly Agree (5), Agree (4), I do not know (3), Disagree (2), Strongly Disagree (1). The 30 questions were divided to three domains (i) Attitudes of students towards chemistry, (ii) Attitudes of students towards chemistry teachers and, (iii) Attitudes of students towards non-formal chemistry education. The items were categorized as positive and negative statements to draw the attention of the respondents. The items with positive numbers and phrases were given values of (5,4,3,2,1), where as the negative phrases were given negative weights in increasing order (1,2,3,4,5). Scores were evaluated separately and then the total scores summed up for each student.

Table (1) summarizes the number of positive and negative items in each domain

Table (1)
Number of positive and negative items in each domain

Domain	**Items**		**Sum of items**	**Percentage of the domain**
	positive	Negative		
Attitudes of students towards chemistry	4	6	10	33.33%
Attitudes of students towards chemistry teachers	7	3	10	33.33%
Attitudes of students towards non-formal chemistry education	6	4	10	33.33%

Interpretation of the Total Score Range

The scale measures for students' attitudes towards chemistry in table 2 ranged from 30 to 150 points. For positive items, the high average reflects a more positive trend to learning chemistry, and the low average reflects a negative trend. For the negative items, the high total score corresponds to, lower average which reflects a low trend towards learning chemistry, and the high average reflects a positive trend to the subject.

Table (2)

Interpretation of the Total Score Range

Total Score	**Average**	**percentage**	**Level of trend**
For positive items			
150-105	5 -3.5	Above 70%	High
104-75	3.49-2.5	69.5-50%	Average
Below 74	Below2.49	Below 49.5%	Low
For negative items			
Below 74	5 -2.5	Below 49.5%	High
104-75	2.49 -1.5	69.5-50%	Average
150-105	Below 1.49	Above 70%	Low

Reliability and Validity

The questionnaire was inspected and checked by secondary schools chemistry teachers for content validation. The reliability of the instrument was calculated using Cronbach's Alpha formula and found to be 0. 81.

Results and Discussion

To provide answers to the research questions raised earlier, data were analyzed, and the mean and standard deviation are presented in Appendix II.

Study Question 1

"Do students have positive attitudes towards chemistry?"
Table (3) illustrates the results obtained from relevant questions.

Table (3)
Attitudes of students towards chemistry

no	Item trend	Item	Percentage %	average	SD	Level of trend
1	positive	Chemistry increases my faith in God Almighty	93.2	4.66	0.6	High
2	positive	Chemistry has a major role in solving the problems of humanity	65.1	3.2	1.1	average
3	negative	I believe that studying chemistry is a waste of my time	70.0	1.53	1.9	Low
4	negative	I wish chemistry is canceled from school schedule	73.9	1.30	0.93	Low
5	negative	Chemistry is a difficult subject	80.8	1.00	1.9	Low
6	negative	I feel bored when I study chemistry	61.8	1.91	1.3	Average
7	negative	Chemistry demands too much calculation	65.5	1.72	1.7	Average
8	negative	Chemistry is not my favorite subject	82.7	0.87	1.4	Low
9	positive	Chemistry plays an important role in our lives	73.1	3.65	1.0	High
10	positive	I intend to study chemistry at university level	10.3	0.51	1.9	Low
Average: 2.1						

Table (3) reveals great appreciation of chemistry as an important subject. About 93% of respondents considered that chemistry increases their faith in God Almighty, about 75% believed that chemistry has a major role in solving the problems of humanity, and about 65% thought that it plays an important role in their lives. However, 69% believed that studying chemistry is a waste of time, 82.7% did not consider chemistry as their favorite subject, and only 10.3% intend

to study chemistry at university level. In addition, about 81% believed that the subject is difficult, and 54.7% believed that it demands too much calculations. Moreover, 61.8% felt bored when studying chemistry and 73.9% wished chemistry is canceled from the school schedule. The results clearly indicated that students have low attitude towards chemistry, as also shown by the total average of 2.10 (see table 3). The low attitude due to the difficulty of the chemistry course, and the lack of interest in the subject is in line with Sirhan findings (Sirhan, 2007).

Study Question 2

"Are students' attitudes towards chemistry a result of their teachers' approach?"

Table (4)
Attitudes of students towards chemistry teachers

no	Item trend	Item	Percentage%	average	Sd	Level of trend
11	positive	I have a good personal relationship with my chemistry teacher	85.1	4.25	0.9	High
12	negative	My chemistry teacher does not make use of teaching aids while teaching	62.2	1.85	1.6	Average
13	positive	My chemistry teacher is highly motivating while teaching	29.9	1.44	1.3	Low
14	negative	My chemistry teacher is incompetent	52.1	2.3	1.8	Average
15	positive	My chemistry teacher helps me to understand many natural phenomena associated with chemistry	45.01	2.25	1.6	Low
16	positive	My chemistry teacher plays a role in developing my thinking	56.0	2.8	1.5	Average

17	positive	I usually ask many questions in the chemistry class	62.1	3.1	1.3	Average
18	positive	Teaching skills of my chemistry teacher are obsolete	67.2	3.35	1.0	Average
19	positive	My chemistry teacher teaches in an enjoyable way	58.5	2.9	1.4	Average
20	negative	Chemistry is too abstract due to the way the teacher teaches it	85.1	0.75	1.1	Low
Average: 2.91						

Table (4) reveals that students attitude toward chemistry teacher is low (average of 2.9) although 85. 1% of them had good personal relations with their chemistry teachers. They still have low attitude towards the way they teach. Items (13-20) depicted that most of the teachers were not motivators, and teach in an unattractive, abstract ways. Items (14-18) revealed that some teachers are incompetent and use obsolete teaching methods. Moreover, items (15-16-17-19) showed that several teachers do not put serious efforts to raise the students' thinking. These findings are also in agreement with the findings of (Berge, 2005a) and (Abulude, 2009).
From the foregoing, it could be deduced that the way chemistry teachers approach the material contribute to the negative attitude of the students to the subject.

The teacher's role could be improved by better recruitment, retraining for young teachers on modern methods of teaching such as using web-based learning in chemistry. They should be given the privilege to attend seminars, workshops and conferences so that they are acquainted with the recent developments in the teaching world.

Study Question 3

"Are students' attitudes towards chemistry a result of the non-formal educational materials?"

To answer this question, ten items were analyzed and the results are presented in Table 5

Table (5)
Attitudes of students towards non-formal chemistry education

no	Item trend	Item	Percentage%	average	Sd	Level of trend
21	positive	I read scientific stories	75	3.75	1.1	High
22	negative	We don't use the chemistry lab until we are in high levels	66	1.7	1.5	Average
23	positive	I like participating in the preparation of chemistry bulletin materials	62	3.1	1.6	Average
24	negative	laboratory equipments are inappropriate	55	2.25	1.8	Average
25	positive	We get involved in many science fairs	40	2.0	1.9	Low
26	positive	Schools arrange constant visits to chemistry museums and exhibitions	55	2.75	1.1	Average
27	positive	I always look for scientific experiments on the Internet	73	3.65	1.4	High
28	positive	I try to do some scientific experiments at home	62	3.1	1.1	Average
29	negative	Chemistry is an abstract subject because we do not see applications of the things we study	85	0.75	1.8	Low
30	positive	I discuss scientific chemistry topics with my colleagues	59	2.95	1.9	Average
Average: 2.6						

Results from table (5) indicate that non-formal educational materials, such as; museums and exhibition visits, science fairs, and press science could influence students' attitude. This result is in line with (Salta, and Koulougliotis, 2007).

Enhancement of students' motivation towards science can be achieved via careful design of the non-formal instructional education. The type of scientific experiments, stories, and frequent visits to the chemistry labs, seemed to stimulate students' interest and motivate them towards further readings.

The online information has the potential to make available to the students the most current information including modeling, simulations, and visualization tools that demonstrate abstract chemistry phenomena. This would increase students' understanding of chemistry concepts (Frailich, Kesner, & Hofstein, 2007).

Study Question 4

"Are there gender differences in student attitudes toward chemistry?"

Hypothesis

Null Hypothesis to be tested:

There is no gender difference between male and female students' attitudes toward chemistry: $H_0: m_f - m_m = 0$

The Null hypotheses H_0 is: there is no significant difference in the average of the 10^{th} grade male and female students' attitudes towards chemistry at ($\alpha<0.05$)

Table 6 shows male and female students' mean, standard deviations (SD), degree of freedom (df), and (sig) score. A *t* test failed to reveal a statistically reliable difference between the mean of 10^{th} grade male (M =2.5, SD=1.07) and that of the female students (M = 2.19, SD = 1.07), t (101) = 1.4, p =0 .156, α = .05. Since (p= 0.156) > ($\alpha<0.05$) which means that there is no significant difference between the 10^{th} grade male and female students' attitudes toward chemistry.

Table (6)

Number of students (N), mean (M), standard deviation (SD), df, sig, and F values of male and female students' attitude toward chemistry

Gender	N	M	SD	Df	t Equal variance	F	P (sig)
Male	50	2.5	1.07	101	1.4	0.287	0.156
Female	53	2.19	1.14				

$\alpha \leq 0.05$

The literature revealed mixed findings regarding gender and attitudes towards chemistry. In some cases girls showed more positive attitude towards chemistry, and in other cases, the opposite prevailed. According to Cheung's review (2009); Steinkamp and Maehr (1984), and Shannon (1982) reported that girls found chemistry more enjoyable than boys, whereas Stable (1986) and Barnes (2005) revealed the opposite. Although the research findings were mixed, in our study the attitude of boys and girls towards chemistry is equal. This is encouraging since there is great concern regarding the number of contributions of the women in the sciences (Kahle and Meece, 1994).

Conclusion:

What promotes attitudes toward learning chemistry remains unequivocal, In this study, an attempt was made to analyze some factors related to the attitudes toward learning chemistry, The findings revealed that whether the student is a male or female, he/she has a low attitude toward learning chemistry, the causes could be basically due to the difficulty of the material, the low awareness of the importance of chemistry in our daily life, lack of exposure and fieldtrips, unattractive and low equipped laboratories, together with the poor motivated teachers.

These findings, hopefully, will provide some useful information on how to bridge between students' attitude toward chemistry and the material, by paying attention to school education that addressed the non-formal learning.

The present findings also provide insight information to the school science teachers and science curriculum planners to revise their teaching and learning methods, so that students' attitude towards learning and engagement in chemistry activities increase.

References

1. Abulude, Olawale, (2009): Students' Attitudes towards Chemistry in Some Selected Secondary Schools In Akure Southlocal Government Area, Ondo State, unpublished dissertation, *Affiliate of the Usman Dan Fodio University Sokoto*

2. Abdullah N. M. (2009): Blame government for mass failure – Mataimaki TonMaiyashi. Daily Trust: The Online Edition

3. Adesoji, F.A. (2008): Managing Students' Attitude towards Science through Problem – Solving Instructional Strategy. *Anthropologist*, 10(1): 21-24.

4. Barnes .G., Mclnerney D. M. and Marsh H. W. (2005): Exploring sex differences on science enrolment intentions: An application of the general model of academic choice. *Australian Educational Researcher.* 32(2): 1-23

5. Berg, Anders (2005a): Learning Chemistry at the University level, unpublished dissertation, Department of Chemistry, Uma University, S-90187 Umeå, Sweden.

6. Berg, Anders (2005b): Factors related to observed attitude change toward learning chemistry among university students, *Chemical Education Study and Development, Department of Chemistry,* Kemihuset,Umeå Universitet, 90187, Umeå, Sweden.

7. Chang ,Shu-Nu (2009): Ninth Graders' Learning Interests, Life Experiences
8. and Attitudes Towards Science & Technology, *Sci Educ Technol* , Vol 18:pp 447–457.

9. Cheung, D. Students' attitude towards chemistry lessons: The interaction effect between grade level and gender, *Research in Science Education*, **39**,75-91, 2009.

10. Corps, Peace (2004): ***Nonformal Education Manual***, Information Collection and Exchange, ICE NO. M0042.

11. Dalgety J. & Coll R.K., (2003), *Students' perceptions and learning experiences of tertiary*
12. *level chemistry,* Annual meeting of the National Association for Research in Science
13. Teaching. Philadelphia.

14. Etllng ,Arlen(1998): **What is Nonformal Education?** Assistant Professor. The Pennsylvania State University

15. Frailich, M., Kesner, M., & Hofstein, A. The influence of web-based chemistry learning on students' perceptions, attitudes, and achievements, *Research in Science and Technological Education,* **25**, 179-197, 2007.

16. Hofstein, Avi and Naaman, Rachel (2011): High-School Students' Attitudes toward and Interest in Learning Chemistry, *Universidad Nacional Autónoma de México*, ISSNE 1870-8404.

17. Holbrook, Jack(2005): Making Chemistry Teaching Relevant, *Chemical Education International, Vol. 6, No. 1.*

18. Hoppers, Wim (2007): Non Formal Education and basic Education Forms: International Institute For Educational Planning (UNESCO) *http://www.unesco.org/iiep/PDF/pubs/K16.pdf*

19. Jegede, S. A. ,(2007): Students' anxiety towards the learning of Chemistry in some Nigerian secondary schools, *Educational Study and Review* Vol. 2 (7), pp. 193-197, July 2007.

20. Johnstone, Alex (2006): Chemical education research in Glasgow in perspective**,**
21. *Centre for Science Education*, University of Glasgow, Glasgow, G12 8QQ, UK.

22. Kahle, J. B., & Meece, J. Research on gender issues in the classroom. In: D. L. Gabel. (Ed.) *Handbook of research on science teaching and learning* (pp. 542-557), New York: Macmillan, 1994.

23. Lewis, Eileen and Seymour, Elaine (1995): Attitudinal Survey, Department of Chemistry University of California, Berkeley, Bureau of Sociological Study University of Colorado, Boulder.

24. Mackenzie A.M., Johnstone A.H. & Brown R.I.F., (2003), Learning from problem based learning, *University Chemistry Education, 7*, 1-14.

25. Morgil, İ., Seçken, N., & Yücel, A.S. (2004). Based on Some Investigation of Self-efficacy Beliefs of Pre-service Chemistry Teachers Variables, *BAU Science Inst. Journal*, 6(1).

26. Sirhan, Ghassan (2007): Learning Difficulties in Chemistry: An Overview, *Journal of Turkish Sciences Education*, Volume 4, Issue 2, pp2-20.

27. Osborne, J., & Dillon, J.(2008): *Science education in Europe: Critical reflections*. London: The Nuffield Foundation,.

28. Oskamp, S. & Schultz, P. W. (2005). Attitudes and Opinions. *Mahwah, NJ: Lawrence Erlbaum Associates*.

29. Özden, Mustafa(2007): An Investigation of Some Factors Affecting Attitudes toward Chemistry in University Education, *Adıyaman University* ,Turkey.

30. Perry W.G., (1970), Forms of Intellectual and Ethical Development in the College Years: A scheme, Holt, Rinehart and Winston, New York.

31. Popoola M. A. (2008): Factors Affecting Teaching and Learning of Agricultural science in Secondary schools (A case study of Akure South Local Government Area of Ondo State. Unpublished PGDE Thesis, *National Teachers Institute*, Kaduna, Nigeria

32. Salta, Katerina and Koulougliotis, Dionysios(2011) : Students' Motivation to Learn Chemistry: The Greek Case. *Technological Educational Institute (TEI) of Ionian Islands* (Greece)

33. Salta, Katerina and Tzougraki, C., (2004). "Attitudes toward chemistry among 11th grade students in high schools in Greece", *Science Education* 88, 535-547.

34. Shwartz Y., Ben-Zvi R. and Hofstein A., (2006), "Chemical literacy: what it means to scientists and school teachers?", *Journal of Chemical Education* 83, 1557-1561.

35. Taber, K. S., (2002). Alternative Conceptions In Chemistry: Prevention, Diagnosis
36. And Cure? London: *The Royal Society of Chemistry*.

37. Yara P. Olatunde (2009): Students' attitude towards mathematics and academic achievement in some selected Secondary Schools in South-western Nigeria. *European Junior of Scientific Study*. 36(3): 336-341

38. Ware, S. A. Teaching chemistry from societal perspective, *Pure and Applied Chemistry*, **73**(7), 1209-1214, 2001.