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 10th 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 الرئيسية لتعليم العلوم وتعلمها. في هذه الدراسة تتبعة العوامل التي تؤثر إيجاباً على اتجاهات عينة قومها (103) طلباً (ذكور وأنثى) من طبقة الصف العشرين 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 أداء 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 تعلم الكيمياء. كما أظهرت الدراسة أنه لا يوجد اختلاف بين اتجاهات الإناث والذكور نحو تعلم الكيمياء. وأوصت الدراسة بالاهتمام بصياغة 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 10th 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 10th 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), whereas 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>
<thead>
<tr>
<th>Domain</th>
<th>Items</th>
<th>Sum of items</th>
<th>Percentage of the domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes of students towards chemistry</td>
<td>4 positive, 6 negative</td>
<td>10</td>
<td>33.33%</td>
</tr>
<tr>
<td>Attitudes of students towards chemistry teachers</td>
<td>7 positive, 3 negative</td>
<td>10</td>
<td>33.33%</td>
</tr>
<tr>
<td>Attitudes of students towards non-formal chemistry education</td>
<td>6 positive, 4 negative</td>
<td>10</td>
<td>33.33%</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Total Score</th>
<th>Average</th>
<th>percentage</th>
<th>Level of trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>For positive items</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150-105</td>
<td>5 -3.5</td>
<td>Above 70%</td>
<td>High</td>
</tr>
<tr>
<td>104-75</td>
<td>3.49-2.5</td>
<td>69.5-50%</td>
<td>Average</td>
</tr>
<tr>
<td>Below 74</td>
<td>Below2.49</td>
<td>Below 49.5%</td>
<td>Low</td>
</tr>
<tr>
<td>For negative items</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 74</td>
<td>5 -2.5</td>
<td>Below 49.5%</td>
<td>High</td>
</tr>
<tr>
<td>104-75</td>
<td>2.49 -1.5</td>
<td>69.5-50%</td>
<td>Average</td>
</tr>
<tr>
<td>150-105</td>
<td>Below 1.49</td>
<td>Above 70%</td>
<td>Low</td>
</tr>
</tbody>
</table>

**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

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

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)**

<table>
<thead>
<tr>
<th>No</th>
<th>Item trend</th>
<th>Item</th>
<th>Percentage%</th>
<th>average</th>
<th>Sd</th>
<th>Level of trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>positive</td>
<td>I have a good personal relationship with my chemistry teacher</td>
<td>85.1</td>
<td>4.25</td>
<td>0.9</td>
<td>High</td>
</tr>
<tr>
<td>1</td>
<td>negative</td>
<td>My chemistry teacher does not make use of teaching aids while teaching</td>
<td>62.2</td>
<td>1.85</td>
<td>1.6</td>
<td>Average</td>
</tr>
<tr>
<td>1</td>
<td>positive</td>
<td>My chemistry teacher is highly motivating while teaching</td>
<td>29.9</td>
<td>1.44</td>
<td>1.3</td>
<td>Low</td>
</tr>
<tr>
<td>1</td>
<td>negative</td>
<td>My chemistry teacher is incompetent</td>
<td>52.1</td>
<td>2.3</td>
<td>1.8</td>
<td>Average</td>
</tr>
<tr>
<td>1</td>
<td>positive</td>
<td>My chemistry teacher helps me to understand many natural phenomena associated with chemistry</td>
<td>45.01</td>
<td>2.25</td>
<td>1.6</td>
<td>Low</td>
</tr>
<tr>
<td>1</td>
<td>positive</td>
<td>My chemistry teacher plays a role in developing my thinking</td>
<td>56.0</td>
<td>2.8</td>
<td>1.5</td>
<td>Average</td>
</tr>
</tbody>
</table>
I usually ask many questions in the chemistry class  62.1  3.1  1.3  Average
Teaching skills of my chemistry teacher are obsolete  67.2  3.35  1.0  Average
My chemistry teacher teaches in an enjoyable way  58.5  2.9  1.4  Average
Chemistry is too abstract due to the way the teacher teaches it  85.1  0.75  1.1  Low

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

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

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 10th 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 10th 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, $\alpha = .05$. Since ($p= 0.156$) > ($\alpha<0.05$) which means that there is no significant difference between the 10th grade male and female students’ attitudes toward chemistry.

**Table (6)**

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Df</th>
<th>t</th>
<th>Equal variance</th>
<th>$F$</th>
<th>P (sig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>50</td>
<td>2.5</td>
<td>1.07</td>
<td>101</td>
<td>1.4</td>
<td>0.287</td>
<td>0.156</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>53</td>
<td>2.19</td>
<td>1.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\alpha \leq 0.05$
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**


