WCES-2010

Determination of the science process skills and critical thinking skill levels

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Received October 27, 2009; revised December 3, 2009; accepted January 14, 2010

Abstract

In this research, it was tried to determine the science process skill (SPS) and critical thinking skill (CTS) levels of the 8th grade elementary school students. With this purpose, 308 8th grade students from each of high, middle, and low socioeconomic level schools (totally from six schools) in a randomly selected province of Aegean region were selected as the sample. At the end of the research, it can be said that the students who completed elementary education have middle level developed SPS and CTS. And it is thought according to this research findings that it is important to perform more comprehensive instruction by using different measurement tools.

Keywords: Science process skills; critical thinking skill; elementary education; science education; grade level.

1. Introduction

Nowadays, the aim of the education and science education is to educate individuals who can adapt to different conditions, think flexible, question, be creative, think critical and multi-directional, solve problems, use the science process skills while solving the problems, consider the world by the point of view of a scientist, respect the people, and tolerate the ideas. One of these aims is to able to use science process skills while solving the problems (MEB, 2006; Tümkaya and Aybek, 2008).

The science process skill, as well as being a necessary tool to learn and understand the science, is also an important aim in science education. Not only the scientists, but also all individuals in the society should have these skills in order to be scientific literate, and to solve the problems encountered in daily life (Aktamış, 2009). In this context, the science process skills are defined as the skills which help to learn, provide to gain the discovering and researching ways and methods, increase the permanence of the learning, make the students active, improve the responsibilities of the students, and help them to understand the practical studies, improve the sense of taking responsibility on their own learnings (Pekmez, 2000; Taşar, Temiz and Tan, 2001).

And the other aim of science education is to educate individuals who can think critically. Many different definitions exist in field literature for the critical thinking. Some of these are given below;

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1. Introduction

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The science process skill, as well as being a necessary tool to learn and understand the science, is also an important aim in science education. Not only the scientists, but also all individuals in the society should have these skills in order to be scientific literate, and to solve the problems encountered in daily life (Aktamış, 2009). In this context, the science process skills are defined as the skills which help to learn, provide to gain the discovering and researching ways and methods, increase the permanence of the learning, make the students active, improve the responsibilities of the students, and help them to understand the practical studies, improve the sense of taking responsibility on their own learnings (Pekmez, 2000; Taşar, Temiz and Tan, 2001).

And the other aim of science education is to educate individuals who can think critically. Many different definitions exist in field literature for the critical thinking. Some of these are given below;
It can be said that the critical thinking requires thinking deeply, being active, having purpose, being conscious, questioning, judging, thinking what to believe or not, and thinking what to do, and regarding these while deciding (Akar, 2007).

The critical thinking is a thinking way where the prejudices, assumptions, all kinds of informations presented were tested and evaluated; their different aspects and results were discussed, and which intends to reach to a decision eventually (Argüden, 2007).

The critical thinking is the individuals’ mental or intellectual skills such as verifying a knowledge or assertion, using various criteria while deciding about a subject, trying to provide evidences related to the something read or heard, before accepting the claims or ideas of others requesting them prove these according to various basis, and being certain, honest, consistent, and having integrity (Özdemir, 2005).

We encounter the critical thinking skills in field literature in several different classifications;

The critical thinking is an intentional, and self regulatory decision-making mechanism resulting with the explanations of the evidentional, conceptual, methodical, criterion-related, contextual investigations which decision is based on together with comment, analysis, evaluation, and inference (Demir, 2006).

Watson and Glaser (1964) divided the critical thinking skills into these sub-steps; a) recognizing the problem, b) ability to choose the proper informations for the solution of the problems, c) ability to take into consideration the defined or undefined situations, ç) ability to choose the informations related to the subject, to formulate, and to hypothesize, d) ability to judge the validity of the result and the inferences (Akt. Çalıskan, 2009). Yeh (2002) stated that the critical thinking skill is a cognitive process containing analysis, comment, evaluation, inference, explanation, and self regulating.

Nowadays the students are expected to be individuals who are questioning, wondering the reasons, and researching, recognizing the conflicts and contradictions, making good observations and making right inferences from these observations, thinking scientifically, criticizing, producing, aware of the ways to reach to knowledge, creative, decision-maker, responsible, expressing himself/herself, not memorizing the information, but aware of the ways to reach, use, share, and produce the knowledge, in other words, have science process and critical thinking skills; and the educational curriculums are prepared according to this.

When the vision of the Science and Technology Curriculum is examined, it is seen that it is stated that all of the students should be educated as a Science and Technology literate. In this context, in 2005 Science and Technology Curriculum, it is expressed as “Being a Science and Technology literate is a combination of the individuals’ developing researching-questioning, critical thinking, problem solving and decision making skills, being a life long learning individuals, and the science skills, attitudes, values, understandings, and knowledge required to continue the curiosity about their environments and the world. … A Science and Technology literate can understand and use properly the nature of science, and nature of scientific knowledge, fundamental science concepts, principles, laws and theories; use the science process skills while solving the problems and making decisions”. In order the students who are about to complete their elementary educations to have the attainments related to the critical thinking and science process skills intended to be gained by them during their elementary education periods in the curriculum, it is important to determine the achievement levels of Science and Technology courses about these specified attainments.

For this reason, in this research, it was tried to determine the science process skill (SPS) and critical thinking skill (CTS) levels of the 8th grade elementary school students. Moreover, the differentiation of the students’ science process skill and critical thinking skill levels according to the socioeconomic level and gender was investigated. And for this purpose, the following sub-problems are determined:

1. How is the distribution of the science process skills levels of 8th grade elementary school students?
2. Do the science process skills levels of 8th grade elementary school students differ according to socioeconomic level of their school?
3. Are there any significant differences between students’ sex and their levels of science process skills?
4. How is the distribution of the critical thinking skills levels of 8th grade elementary school students?
5. How is the distribution of the critical thinking skills levels of 8th grade elementary school students?
6. Do the critical thinking skills levels of 8th grade elementary school students differ according to socioeconomic level of their school?
7. Are there any significant differences between students’ sex and their levels of critical thinking skills?
2. Method

The research is survey model, which has an approach aiming to describe the current status (Karasar, 1999). 308 8th grade students from each of high, middle, and low socioeconomic level schools (totally from six schools) in a randomly selected province of Aegean region were selected as the sample. Science process skill achievement test and California Critical Thinking Disposition Inventory (CCTDI) were applied on the selected sample during a lecture hour in the final month of the spring semester. 49.4 % (152) of the students who participated into the research are female, and 50.6 % (156) of them are male. 33.4 % (103) of the students are reading at high socioeconomic level schools, 33.8 % (104) of them are reading at middle socioeconomic level schools, and 32.8 % (101) of them are reading at low socioeconomic level schools.

2.1. Tools for Gather Data

Science Process Skills Test: The original form of the inventory was developed by James R. Okey, Kevin C. Wise and Joseph C. Burns. And its translation and adaptation into Turkish were done by Prof. Dr. Ilker Özkan, Prof. Dr. Petek Aşkara and Prof. Dr. Ömer Geban (Özkan, Aşkara and Geban, 1994; quoted from Yavuz, 1998). The Science Process Skills Inventory consists of 35 items. At the end of the inventory’s reliability study done by Yavuz (1998), the reliability coefficient (KR-20) was found as 0.82. The minimum point which can be taken by the students from SPS test is 0, and the maximum point is 35. While determining the SPS levels of the students; the SPS levels of the students who took below 12 points from the test are accepted as low level, as middle level for the students who took between 12 -24 points, and as high level for the students who took above 24 points.

California Critical Thinking Disposition Inventory: In the research, California Critical Thinking Disposition Inventory (CCTDI) which was created as a result of Delphi Research Project arranged by American Philosophical Association in 1990 and whose adaptation into Turkish, validity, and reliability studies were performed by Kökdemir (2003). This inventory was used in many different studies in Turkey, and its validity and reliability were determined. However, this inventory is convenient for the undergraduate level. Therefore, it was rearranged, and the language of 6-choice grading inventory consisting of 51 items was adapted to elementary school level. In addition to this, the inventory was restructured as 5-choice likert type (Totally Agree=5, Agree=4, Undecided=3, Disagree=2, Totally Disagree=1) to adapt to that level in the directions of the experts. Since new rearrangements were performed on the inventory, and since the level of the subjects to be applied are different, its validity and reliability studies were performed with 369 students. At the end of the factor analysis done, 12 items were removed from the inventory, and the reliability coefficient of the new inventory consisting of 6 factors, and totally 39 items, and expressing 40.36 % of the total variance was found as \( \alpha=0.81 \). This result displays us that an objective and reliable measurement was performed. CCTDI consists of six different dimensions (analyticalness, broadmindedness, curiousness, self-confidence, finding out the truths, being systematic). While California Critical Thinking Disposition Inventory was evaluated by Kökdemir (2003); it was stated as “when CCTDI was handled as a whole, it can be said that the general critical thinking dispositions of the individuals who have points below 240 (40 x 6) is low, and the general critical thinking dispositions of the individuals who have points above 300 (50 x 6) is high”. However, since the inventory was reduced to 5-choice likert type at the end of the reliability and validity studies done in this research, the maximum score to be taken from this inventory is 195, and the minimum score is 39. Therefore, it can be said that the students who have 91 points and below have low critical thinking disposition, the students who have points between 91 and 143 have middle critical thinking disposition, and the students who have 143 points and above have high critical thinking disposition.

2.2. Analysis of Data

During the analyses of the data, unrelated t-test and one way variance analyses are used in order to compare the students’ educational type and class year (formal or evening), gender, type of the school from which they are graduated and high school majors. A Scheffe test is applied in order to determine between which groups were the
differences realized by variance analyses. Analyses are made at SPSS 11.5 package program. 0.05 was the importance level.

3. Results (Findings)

1. Sub-problem of the 1. study: ‘How is the distribution of the science process skills levels of 8th grade elementary school students?’ was asked. The 8th grade elementary school students’ arithmetic mean of dispersion of SPS levels is provided at Table 1 to search for an answer.

Table 1. Distribution of 8th grade elementary school students according to their science process skills levels

<table>
<thead>
<tr>
<th>SPS Level</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>119</td>
<td>38.6</td>
</tr>
<tr>
<td>Medium</td>
<td>166</td>
<td>53.9</td>
</tr>
<tr>
<td>High</td>
<td>23</td>
<td>7.5</td>
</tr>
</tbody>
</table>

When Table 1 is examined, it has been seen that a bit more than half of the students (53.9 %) have middle level SPS, and a few part of the students (7.5 %) have high level SPS. This result displays that SPS attainments existing in Science and Technology Curriculum were gained to the students in middle level.

2. Sub-problem of the 2. Study: “Do the science process skills levels of 8th grade elementary school students differ according to socioeconomic level of their school?” was asked.

Table 2. Distribution of The Students’ Science Process Skills Levels According to The Socioeconomic Status of The School

<table>
<thead>
<tr>
<th>SPS Level</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>103</td>
<td>16.155</td>
<td>6.480</td>
</tr>
<tr>
<td>Medium</td>
<td>104</td>
<td>12.904</td>
<td>4.585</td>
</tr>
<tr>
<td>Low</td>
<td>101</td>
<td>11.832</td>
<td>3.524</td>
</tr>
</tbody>
</table>

As seen from Table 2, there are differences between the arithmetical averages. In order to determine the statistically significance of these differences, one-way analysis of variance was applied, and the results were given at Table 3.

Table 3. The Results of Variance Analysis Regarding the Differentiation of The Students’ Science Process Skills Levels According to School Type

<table>
<thead>
<tr>
<th>Groups</th>
<th>S.P.</th>
<th>F</th>
<th>S.M.</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.A.</td>
<td>1038,30</td>
<td>2</td>
<td>519,15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.ø</td>
<td>7690,692</td>
<td>305</td>
<td>25,21</td>
<td>20,58</td>
<td>.000*</td>
</tr>
<tr>
<td>T</td>
<td>8728,997</td>
<td>307</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* significant at p<.05 level

When Table 3 is examined, it has been seen that the students’ SPS levels are significantly different according to the school type (p<.05). Scheffe test was applied in order to find out from which school type this significant difference was resulted. According to the obtained results, it has been seen that there is a significant difference between the schools having high socioeconomic status, and the schools having middle and low socioeconomic status. When the schools’ average scores taken from SPS test are examined in order to find out in favour of which group this significant difference is, it has been seen that this significant difference is in favour of the school having high socioeconomic status.

3. Sub-problem of the 3. Study: “Are there any significant differences between students’ sex and their levels of SPS?” was asked. The differentiation of students’ SPS levels according to their genders were examined, and the findings at Table 4 were obtained.

Table 4. Differentiation of The Students’ Science Process Skills Levels According to Their Genders

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Means</th>
<th>Standard Deviation</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>156</td>
<td>13.667</td>
<td>5.87</td>
<td>.090</td>
<td>.928</td>
</tr>
<tr>
<td>Female</td>
<td>152</td>
<td>13.612</td>
<td>5.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* significant at p<.05 level
When Table 4 is examined, it has been seen that there is no difference between the students’ scores taken from Science Process Skills Test according to their genders. It can be said that SPS levels of the students do not change according to their genders.

4. **Sub-problem of the 4. Study**: “How is the distribution of the critical thinking skills levels of 8th grade elementary school students?” was asked. The distribution of the students’ critical thinking skills level was examined, and the findings at Table 5 were obtained;

<table>
<thead>
<tr>
<th>CTS Level</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Medium</td>
<td>238</td>
<td>77.3</td>
</tr>
<tr>
<td>High</td>
<td>69</td>
<td>22.4</td>
</tr>
</tbody>
</table>

When Table 5 is examined, it has been seen that the students’ critical thinking skills levels are mostly in middle level (77.3 %), only a few parts of them (22.4 %) have high level critical thinking skills, and only one of the students (3 %) has low level critical thinking skills. It can be said that the students’ critical thinking skills level is in middle level.

5. **Sub-problem of the 5. Study**: “How is the distribution of the critical thinking skills levels of 8th grade elementary school students?” was asked. The students’ critical thinking skills levels were examined according to the socioeconomic status of the school, and the findings at Table 6 were obtained.

<table>
<thead>
<tr>
<th>CTS Level</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>103</td>
<td>2.291</td>
<td>.478</td>
</tr>
<tr>
<td>Medium</td>
<td>104</td>
<td>2.211</td>
<td>.410</td>
</tr>
<tr>
<td>Low</td>
<td>101</td>
<td>2.158</td>
<td>.367</td>
</tr>
</tbody>
</table>

When Table 6 is examined, it has been seen that there is no difference between the arithmetical averages. According to this result, it was determined that there is no significant difference between the socioeconomic status of the schools and the students’ critical thinking skills levels.

6. **Sub-problem of the 6. Study**: “Are there any significant differences between students’ sex and their levels of CTS?” was asked. The differentiation of students’ CTS levels according to their genders were examined, and the findings at Table 7 were obtained.

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Means</th>
<th>Standard Deviation</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>156</td>
<td>2.224</td>
<td>.4</td>
<td>.150</td>
<td>.881</td>
</tr>
<tr>
<td>Female</td>
<td>152</td>
<td>2.217</td>
<td>.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* significant at p<.05 level

When Table 7 is examined, it has been seen that there is no difference between the students’ scores taken from Critical Thinking Skills Test according to their genders. According to this, it can be said that the students’ genders do not affect their CTS levels.

4. **Discussion, Conclusion and Recommendation**

As a result of the research findings obtained, it can be said that SPS and CTS levels of the students who completed elementary education were developed in middle level. However, when the students’ SPS levels are examined, it draws attention that there are lots of students who have low SPS levels. And when the distribution of the students are examined according to the CTS level, it has been seen that the number of students who have high developed CTS level is more than the number of the students who have undeveloped CTS level. This result displays that the Science and Technology Curriculum is about to achieve its target of educating individuals who gained
critical thinking skills, and who are Science and Technology literate. However, it can be said that the SPS skills attainments were less gained by the students. In 2008-2009 academic year, Science and Technology Curriculum produced its first graduates. It is seen that inexperience of the teachers about the curriculum who first started to apply the curriculum, and not to run smoothly of the curriculum affected the development of SPS and CTS levels of the students in middle level.

When the students’ SPS levels are examined according to the socioeconomic status of their schools, it has been seen that the result is in favour of the school having high socioeconomic status. It can be thought that it is caused by the education opportunities of the schools having high socioeconomic status, educational levels of the families and the concern level of the parents about their child.

When the correlation of the students’ genders and their SPS and CTS levels are examined, it has been seen that there is no significant difference between them. And this result displays that the students’ genders do not affect their SPS and CTS levels.

When the students’ CTS levels are examined according to the socioeconomic status of their schools, it can be thought that the socioeconomic status of the schools has no effect on the development of their CTS levels. In the researches investigating the effect of the socioeconomic level on the development of critical thinking skills, it is put forward that there is no correlation between CTS and socioeconomic level (Özdemir, 2005; Dil and Öz, 2005; Türkaya and Aybek, 2008).

The suggestions made in the scope of the results obtained at the research;

It is important to investigate the effects of Science and Technology Curriculum by means of a longitudinal study in 4th, 5th, 6th, 7th, and 8th grades separately to display the curriculum’s efficiency, its success on achieving its target, and its development.

The SPS levels of the students can be evaluated not only by a multiple-choice test applied, but also by means of the inventories containing different types of questions, interviews, and observations. Similarly, theCTS levels of the students can be evaluated not only by an inventory, but also by means of the other evaluation methods such as observation and interview. By this way, both how much the curriculum achieved its attainments, and the SPS and CTS levels can be put forward explicitly.

References


