Assessing Argumentation, Critical Thinking and Value Judgment of Non Science Majors

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“Treasures of the Sea – Use and Abuse”

- *Science for All* unit for non-science majors in high school
- STS approach – emphasizing social, technological and environmental aspects
- Relevant; focus on local issues – the Mediterranean coastline
- System approach – huge number of living organisms, millions of people, and a great number of organizations are affected by human actions

- Aims at educating towards *sustainability*, so that we use our resources responsibly.
Socio-scientific Issues/controversies

- Those issues on which our society is clearly divided about; significant groups within society advocate conflicting explanations or solutions based on alternative values (Stradling, 1985)

- “The nature of controversial issues need to be understood by pupils and teachers. This should be at the heart of the educational endeavor” (Oulton et al., 2004)
Fostering students’ higher order thinking skills is considered as an important educational goal (AAAS, 1993; NRC, 1993; Resnick, 1987; UNESCO, 2000; Israeli standards)

- **Reasoning/argumentation** – generation and evaluation of positions in response to complex issues that lack clear-cut solutions (Driver et al., 2000)

- **Value judgment** – based on moral codes or related ethical principles held by an individual. Judgments in relation to what is “good”, “worthwhile” or “ought to be done” (Peters, 1996)
“Treasures of the Sea” – Content

- Knowing the seas and the oceans
  Earth sciences
- Sea water – substances and forces
  Physical sciences
- Living things – algae and animals
  Life sciences

Humans - actions and consequences

- Marine Agriculture
- Marine environment
Skills

- System thinking
- Analyzing information presented in text
- Representing knowledge in various forms

- Argumentation
- Value judgment

Focus of the environmental chapter
Objective

- To assess students' performances in tasks that encourage using higher order thinking skills such as:
  - argumentation
  - value judgment
Method

- A class of low achievers (grade 11), non-science majors studied the module
- Two classes of Environmental Sciences majors (grade 10; grade 11)
- Altogether – 26 small groups of (2-4) students

- 4-5 authentic performance tasks were developed in order to promote argumentation, decision making, system thinking and value judgment

- 2 tasks (pre/post) were used for assessing 1) argumentation and decision making 2) value judgment
  
  - Interviews
  - Observations
Read the article “The government postponed the decision regarding the fish farming device future…” [Haaretz (daily newspaper) 14/3/04]

What is the problem that the article raises?
Explain the possible influences of the fish cages
Various groups have different interests with regards to this issue:
– Indicate at least 3 groups of stakeholders, what are the interests of each group? Could you identify conflicting interests?
What are the considerations that ought to direct the decision makers? (address values, environmental, economic, social, legal..); do you find any conflict between them?
You were appointed to the “planning committee of the region” and have to decide on one of the two alternatives: a) leaving the cages in the bay water; b) moving the fish into ponds built on the land.
– What would be your justified recommendation?
– If the group cannot reach a decision, please indicate the different opinions and vote
Assessing argumentation

<table>
<thead>
<tr>
<th>Skill</th>
<th>Criteria</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argumentation</td>
<td>Number of justifications</td>
<td>I believe we should take the cages out, because they pollute the sea: The food and medicines hurt the corrals and increase turbidity. The fish secreting cause disease, and escape of fish could change the ecological balance. If we move them to land, the workers would not be harmed, but the cages would not affect marine organisms.</td>
</tr>
<tr>
<td></td>
<td>Considering scientific knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Addressing counter arguments</td>
<td></td>
</tr>
<tr>
<td>Value Judgment</td>
<td>Justified decision, addresses: worldview, values, ethical principles; declaring what is good, worthwhile, ought to be done</td>
<td>I believe animal welfare is the most important issue here. The fish suffer in those metal cages. They get wounded.</td>
</tr>
</tbody>
</table>
Assessing value Judgment (1): Specific

<table>
<thead>
<tr>
<th>Score</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>There was no decision making/ clear position</td>
</tr>
<tr>
<td>1</td>
<td>There was decision making/clear position, but no justification, or the justification was poorly presented</td>
</tr>
<tr>
<td>2</td>
<td>There was decision making/clear position, which included a coherent justification</td>
</tr>
</tbody>
</table>
| 3     | In addition, the answer incorporated a few of the following:  
  a. Identifying moral issue at stake  
  b. Identifying the relevant knowledge and unknown facts in a problem  
  c. Offering another resolution and providing a justification for it  
  d. Considering alternative scenarios that argue for different conclusion  
  e. Identifying and evaluating moral consequences  
  f. Adding information or evidence which helps to take a stand  
  g. Providing conditions for taking a stand |
Value Judgment (2): General

- Expression/declaration about importance or commitment (to the environment)
- Addressing possible consequence of our actions
- Awareness to conflicting considerations that affect decisions
### Findings - Argumentation

<table>
<thead>
<tr>
<th>Justification</th>
<th>Examples</th>
<th>Pre (Groups)</th>
<th>Post (Groups)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 none</td>
<td>&quot;on one hand, this is an advantage, because the factory would hire employees; on the other hand, it would pollute the sea with mercury compounds. At the end we decided against&quot; (6/04)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>1 one</td>
<td>We think the factory shouldn't be built because it pollutes the sea with mercury (3/04)</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>2 two</td>
<td>We are against the factory…it would hurt the living organisms in the sea and on the coast and ruin natural resources (7/05)</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>3 &gt;3</td>
<td>We are against the factory…it would hurt the fishermen who make their living from the fish, the tourists who come swimming, and the living organisms ... (4/04)</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>
Incorporating Scientific Knowledge

<table>
<thead>
<tr>
<th>Level of Incorporating Knowledge</th>
<th>Examples</th>
<th>Pre (groups)</th>
<th>Post (groups)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – none; or incorrect</td>
<td>The factory will cause waste production…. (5/05) – no scientific knowledge</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1 – Partial;</td>
<td>The factory would pollute the bay (1/04)</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>partial knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2- Correct, relevant</td>
<td>The factory would pollute the sea. It will hurt people and all living being in the sea (fish, plants) and decrease the water quality. We think the sewage should be treated before the factory puts it in the sea (1/05) Correct and relevant knowledge</td>
<td>7</td>
<td>17</td>
</tr>
</tbody>
</table>
### Aspects

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Examples</th>
<th>Pre (groups)</th>
<th>Post (groups)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>We do not want the sea to be polluted. If it is polluted with mercury, so it (the factory) shouldn't be open (1/04)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>On one hand the factory will reduce unemployment, on the other hand it will pollute the environment (6/04)</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>The factory will reduce unemployment, and the seawater, which is a free resource, can be used as raw material. However, it can pollute the shore (5/04)</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Although the factory reduces unemployment, and the seawater is used as raw material, it might pollute the sea with mercury and poison the people that will be exposed to the seawater or will eat the fish (6/05)</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>
## Synthesizing Counterclaims

<table>
<thead>
<tr>
<th>Synthesizing counterclaims</th>
<th>Examples</th>
<th>Pre groups</th>
<th>Post groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 none</td>
<td></td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>1 counterclaims appear, but are not contradicted</td>
<td>On one hand, the factory might pollute the sea and the fish and harm the environment; on the other hand, its establishment could reduce unemployment</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>2 the answer incorporates counterclaims that are rejected</td>
<td>The factory, although it pollutes, has positive aspects... if there is a possibility not to spill wastewater to the sea, it could be worthwhile; but, it's impossible, we are against building the factory, but we understand people who would claim that it would benefit...</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>
Value Judgment

- Overall - not many expressions
  - "Usually, my decisions were pro-environmental ones. It is important that the world would remain as it is, so we would not harm nature any more. We should not interfere…" (Ben)
  - "I was touched by the animals and the environment. This was guiding me while I made my decisions" (Rhona)

  - "Scientific knowledge was the only guiding principle in my decisions" (Omer)
Summary

- Socioscientific issues were found to be engaging to non-science majors
- Authentic performance tasks expressed the learning process in class
- The students enjoyed working and being assessed in groups
- Improvement of argumentation
- Smaller improvement: incorporating knowledge; value judgment
Recommendations

- Teaching thinking skills should be infused in the curriculum
- Time is requires for the students to conduct discussions and shape their thinking (supported by Zohar, 2004)
- Teachers could teach towards value judgment by modeling (supported by Oulton et al., 2004)