

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)

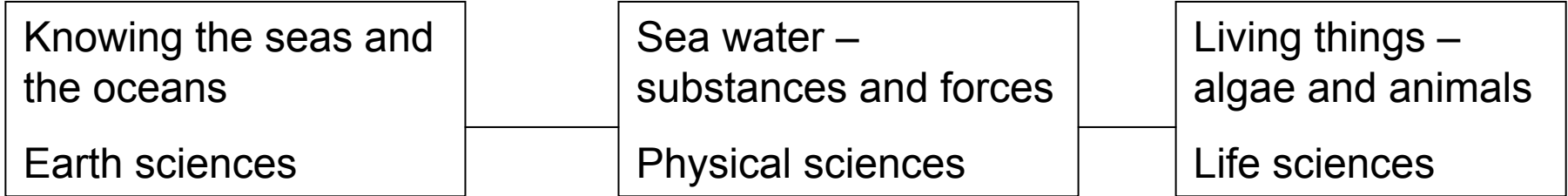


Background

- 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)



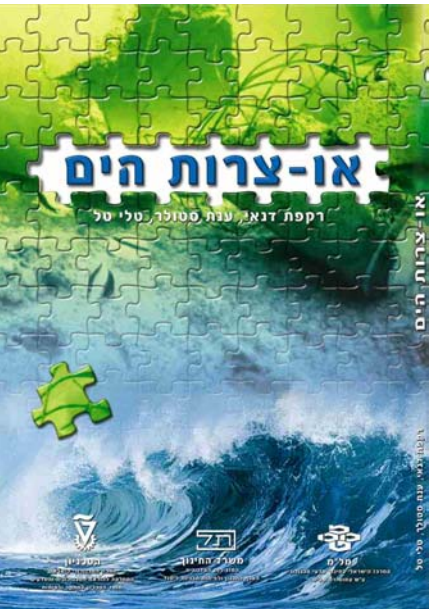
“Treasures of the Sea” – Content



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**



“The Fish-Cages” task

- 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

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



Assessing value Judgment (1): Specific

Score	Explanation
0	There was no decision making/ clear position
1	There was decision making/clear position, but no justification, or the justification was poorly presented
2	There was decision making/clear position, which included a coherent justification
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

Justification	Examples	Pre (Groups)	Post
0 none	"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. <u>At the end we decided against</u> " (6/04)	3	0
1 one	We think the factory shouldn't be built <u>because it pollutes the sea with mercury</u> (3/04)	9	6
2 two	We are against the factory... <u>it would hurt the living organisms in the sea and on the coast and ruin natural resources</u> (7/05)	13	9
3 >3	We are against the factory... <u>it would hurt the fishermen who make their living from the fish, the tourists who come swimming, and the living organisms ...</u> (4/04)	1	11



Incorporating Scientific Knowledge

Level of Incorporating knowledge	Examples	Pre	Post (groups)
0 – none; or incorrect	The factory will cause waste production.... (5/05) – no scientific knowledge	2	1
1 – Partial;	The factory would pollute the bay (1/04) partial knowledge	17	8
2- Correct, relevant	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	7	17



Aspects

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



Synthesizing Counterclaims

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

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 required 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)

