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Reflection—The Story of Water

Marijana Magdić[1], Vlatka Husetović[2] and Mirna Coljak[3]

1. Sesvetska Sela Primary School, Letnička 5, Sesvete, Zagreb 10360, Croatia

2. GrofJanko Drašković Primary School, Vrapčanska 7, Zagreb 10000, Croatia

3. Jelkovec Primary School, Dragana Plamenca 1, Zagreb, Sesvete 10360, Croatia

Abstract: Starting from the fact that water is quite arguably the source of life, the authors agreed to set up a project on water and name it: "REFLECTION". Particular focus was placed on the following issues: water in nature, importance of water in human life, physical and chemical properties of water, protection of water in nature. The aim of the project was to make students aware of the importance of water for health as well as to help them develop a rational relationship towards drinking water. In order to find answers to the issues raised, the authors designed worksheets, PowerPoint presentations, educational games (ecological postcards, dominoes, memory games, etc.). The authors even tried our hand at making a comic strip. Students learned about the influence of water on health, as well as about water content in particular foods. The long-term goal of the project is to introduce children to scientific approach and methodology. Through active participation and dialogue, students discover cooperative learning and acquire skills that will be beneficial to them as well as to the wider community. Working on the project, students' evidence that the role of an individual is a key one in building a better world. This insight helps develop their civic skills and attitudes that serve as the starting point for environmental education. The authors made numerous adaptations and implemented individual approach with the goal of training students for independent work and life according to their personal abilities in line with the principles of inclusive education. Students conduct experiments following step-by-step instructions on specially adapted worksheets. Each student gets positive feedback and experiences the joy of success that leads to the development of self-confidence and love of work and learning.

Key words: Water in nature, water content in foods, nature protection, ecology, education.

1. Introduction

Nowadays, projects are being implemented in all fields of human activity. It is therefore important to educate students about the growing importance of projects and project management in terms of monitoring and control [1, 2].

Water permeates most of the subjects of the school curriculum. However, lecturing on water seems to have little influence on students' attitudes [1, 3].

The aim of this project (Fig. 1) is to build awareness among students about the importance of drinking water, to highlight the importance of water protection and management, to familiarize students with the impact of water scarcity on human health, to develop students' abilities to teach others, to raise awareness among the wider population of a proper relationship to water and to develop environmental awareness as well as a proper attitude towards water conservation and protection [2, 9].

2. Experimental Setup

The aim was to bring the unit entitled "Water in Nature" to life and bring it closer to school and the wider community [6-8]. The project was carried out throughout the school year from December to April.

Students determined the content of water in a particular foodstuff. They explored the dependence of transpiration on the number of leaves. They read about the importance of water for the life of all living beings [5, 8, 9].

Through the activity named "How can I help?" students reflected on drinking water conservation, made comic strips containing messages on water conservation and created educational messages [4, 10-12].

Corresponding author: Marijana Magdić, research field: sensible management with natural resources.

Fig. 1 Project logo.

Fig. 2 Poster for the 25th HSKIKI (Croatian Meeting of Chemists and Chemical Engineers with international participation).

Older students played the role of teachers for their younger schoolmates.

The project was presented in libraries by way of exhibitions and workshops on World Water Day.

On March 22 students took part in an interactive quiz game on water organized at school.

For students the project ended by a group visit to ZOV (Zagreb Wastewater Treatment Plant) where water samples were analysed (Fig. 12) [11].

As for our teachers, the authors presented the project, as an example of good teaching practice, at the 25th Croatian Meeting of Chemists and Chemical Engineers (25th HSKIKI) held in Poreč on April 23 (Figs. 2 and 13).

The authors are currently negotiating for the publication of a book on the project.

3. Experimental Results

3.1 Students Determine the Water Content of Particular Foodstuffs

The students were instructed on how to conduct a mini project at home. Each student had to dry 5 foods (fruits and vegetables) [5]. During the project implementation, each student had to set a hypothesis, conduct the practical test, track observations, draw conclusions and present his or her work [11]. Fig. 3 contains PPT slides showing the work stages and the results obtained while determining water content in an apple.

Students presented the results of their research through models (Fig. 4), posters (Fig. 5), PPTs (Fig. 3). In models, water content in the foodstuff is marked in blue (Fig. 4).

Group results are shown in the Figs. 6-8. The Figs. 6-8 show the ratio of dry matter and water in apples, oranges, bananas, lemons, kiwis, potatoes, carrots and onion. The dry matter content is indicated in red and the water content in blue.

3.2 Students Determine the Dependence of Transpiration on the Number of Leaves

A research on the dependence of transpiration on the number of leaves was carried out on parsley twigs over the course of 24 hours. In the first test tube, the lower surface of the leaves was coated with nail polish in order for the stomata to close. The experiment results suggest that the transpiration of plants depends on the number of leaves and on stomatal conductance.

Fig. 3 PPT slides, water content in apples.

Fig. 4 Apple and orange models.

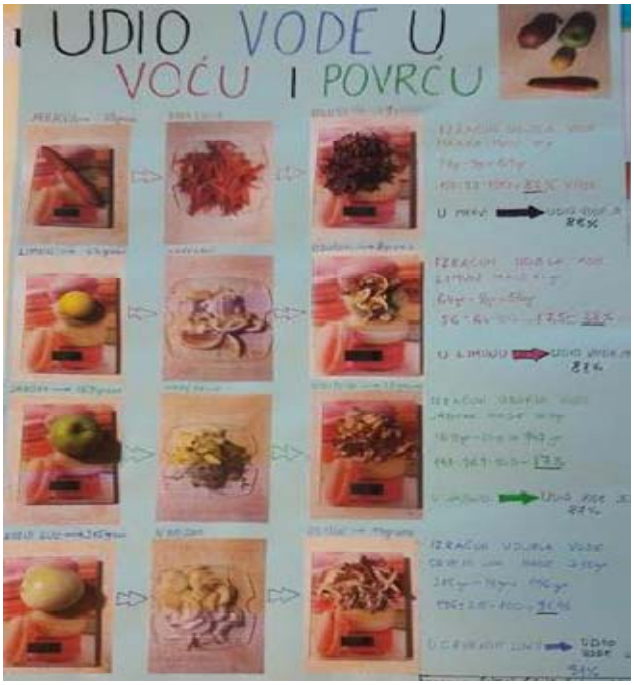


Fig. 5 Poster "Water Content in Fruits and Vegetables".

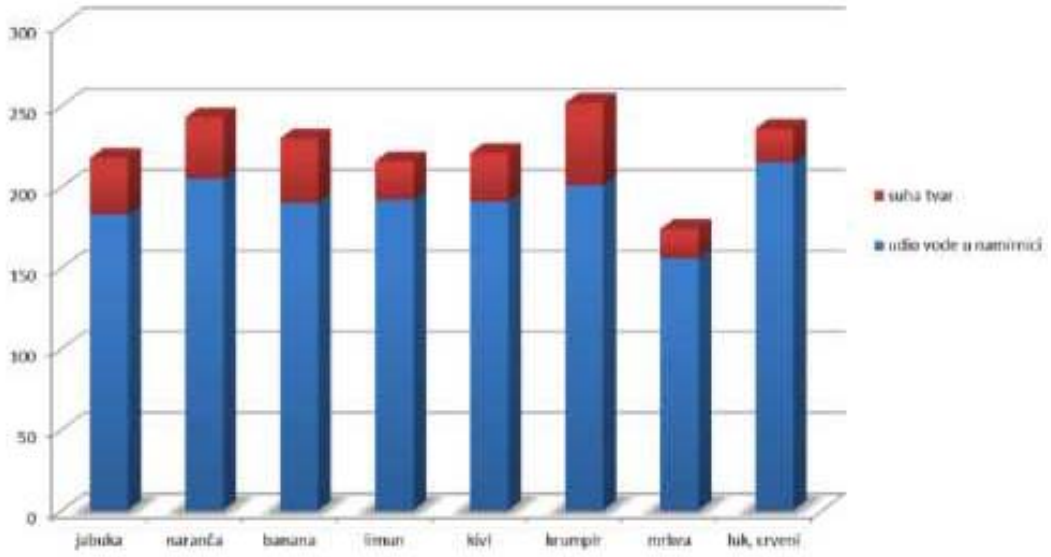


Fig. 6 Water content in foodstuffs.

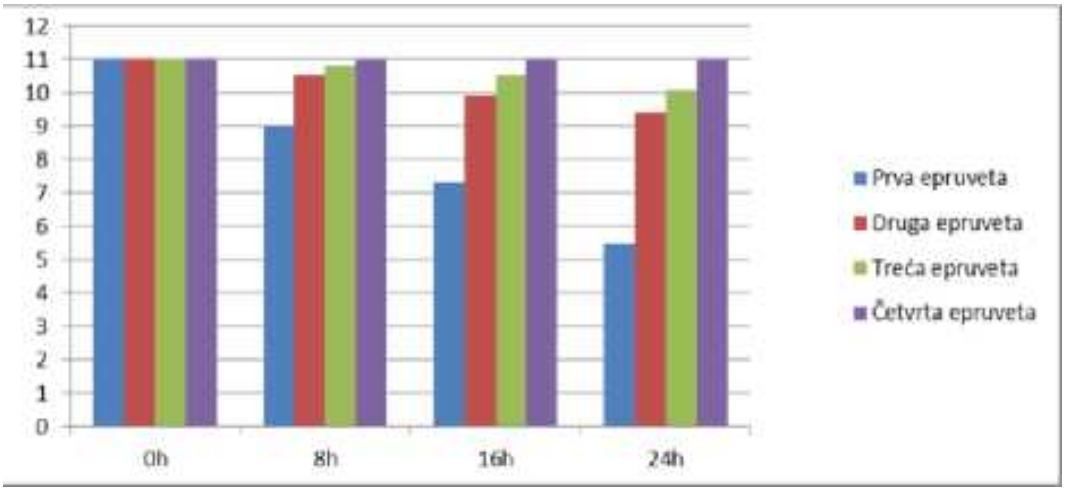


Fig. 7 Water level in test tubes every 8 hours.

Fig. 8 Showing the total water level change in test tubes within 24 hours.

Fig. 7 shows changes in the water level in test tubes within 24 hours.

Transpiration rates are higher in plants with more leaves, whereas transpiration does not occur in plants with closed stomata.

3.3 Students Explore the Importance of Water for the Life of All Living Beings

Studying relevant literature, students explored the importance of water for life on Earth, water flow and circulation in nature [6, 9, 12]. They studied how water is distributed in nature and the ratio of drinking water in the total amount of water in the world. They

learned who the polluters were and in what ways they polluted water, and sought solutions for water purification [12-14]. They also explored ways to construct a water purifier and applied their knowledge to build one.

3.4 Students Make Teaching Materials

Learning many new facts about water was followed up with concrete activities. Through the activity named "How can I help?" students reflected on drinking water conservation. Students made comic strips (Figs. 9 and 10) containing messages on water conservation and created educational messages, all with the aim of informing other students and the wider community.

Fig. 9 Poster and model representing water pollution.

Fig. 10 Educational comic strips made by students.

3.5 Students Teach Other Students

With the help of their mentors the students used the acquired knowledge to organize interactive workshops and transfer their knowledge to others. They organized the following workshops for lower grade primary school pupils: WATER AROUND US, THE PROPERTIES OF WATER and WATER IN NATURE. Each workshop consisted of tests and relevant worksheets where pupils could write their observations, do tasks and draw conclusions. In the WATER AROUND US workshop the pupils purified water, explored the circulation of water in nature and learned about the amount of drinking water. The WATER IN NATURE workshop is about learning the difference between still and flowing bodies of water and about how living beings adapt to their environment. The worksheets for THE PROPERTIES OF WATER workshop are presented below.

1. RESEARCH: THE PROPERTIES OF WATER.
(1) Open the faucet. What do you notice?
The water from the faucet _____
(2) Pour water in a clean glass. Observe its colour. Smell it and taste it.
What colour is it? _____
What does it smell like? _____
What does it taste like? _____
Water has _____ colour, smell and taste.
(3) Take a jug of water. Pour the water in a glass.
What shape is it? _____
Pour the water back into the jug.
What shape is it now?

_____
Does the water have a constant shape?

_____
What does the shape of the water depend on?

_____
DRAW WATER IN:
A GLASS A JUG
2. TEST: SOME SUBSTANCES MELT IN WATER
Pour some water into six glasses.

(1) Add some kitchen salt in the first glass.
(2) Pour some oil in the second glass.
(3) Add some wine vinegar in the third glass.
(4) Add bits of toothpicks in the fourth glass.
(5) Add a metal paperclip in the fifth glass.
(6) Add a paper ball in the sixth glass.
Mix the contents of each glass with a spoon. What do you notice?
_____ melts in water.
_____ does not melt in water.
What conclusions can you draw from this?
_____

3. TEST: MELTING SUGAR IN COLD AND HOT WATER
(1) Pour some cold water in a glass and, with the help of your teacher, pour some hot water in a different glass.
(2) Prepare a stopwatch.
(3) Note the amount of time it takes for a sugar cube to melt in hot water.
(4) Note the amount of time it takes for a sugar cube to melt in cold water.
What conclusions can you draw?
_____

4. TEST: TURNING LIQUID WATER INTO ICE
(1) Pour some water in an ice cube tray and put it in the freezer.
(2) Take the tray out after two hours.
What happened to the liquid water in the freezer?
_____

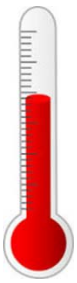
5. TEST: TURNING ICE INTO LIQUID WATER
(1) Take the ice cubes out from the tray.
(2) Hold them in your hands.
(3) Hold the cubes above a metal or a plastic bowl.
(4) What do you feel in your hand?
_____
What happens with the ice?
_____
Why? _____
What happens in the bowl under your hand?
_____

6. TEST: TURNING LIQUID WATER INTO VAPOUR
Do this experiment with the help of an adult!
(1) Observe the water in the pot when it boils. What do you notice?
You notice V ___ P ___ U___above the pot.
What conclusions can you draw?
When you heat water, it turns into G ___ ___.
(liquid, gas)

7. TEST: TURNING VAPOUR INTO LIQUID WATER (Do this experiment with the help of an adult).
(1) Pour some hot water into a plastic bottle.
Let it rest for a few minutes.
(2) Pour the water out from the bottle.
(3) Put the bottle into a cold place (but not the fridge).
What do you notice?
You can see _____ of water on the sides of the bottle.
Conclusion: When it cools, the water turns from gas into _____.
(liquid, solid)

THERMOMETER

READ CAREFULLY!



A thermometer is a device that precisely measures air and water temperature, as well as the temperature of some other substances. Each point of the thermometer represents one degree on the Celsius scale. The height of the temperature is measured in degrees Celsius.

FILL IN THE BLANKS! In lower case!
A thermometer _____ a device that precisely _____ air and_____ temperature, as well as the temperature of some other substances. Each _____ of the thermometer represents _____ degree on the Celsius scale. The height of the temperature is _____ in degrees Celsius.

READ CAREFULLY!

A thermometer is a device that measures the temperatures of certain elements (air, water, land...). In order to measure human body temperature we use medical thermometers.

FILL IN THE BLANKS IN LOWER CASE!

A thermometer ____ _____ _____ measures the temperatures of certain elements (air, _____, _____...). In order to measure _____ _____ temperature the authors use _____ _____.

ANSWER THE QUESTION: What is a thermometer?_____

_____

TASK: Complete the sentences with the words *cool/heat*.

(1) If you _____ (cool/heat) liquid water to temperatures above 100 °C (a hundred degrees Celsius), it turns into VAPOUR.

(2) If you _____ (cool/heat) vapour to temperatures below 100 °C, it turns into liquid water.

(3) If you _____ (cool/heat) solid ice to temperatures above 0 °C, it turns into liquid water.

(4) If you _____ (cool/heat) liquid water to temperatures below 0 °C, it turns into solid ice.

FILL IN THE BLANKS! Water in nature is found in three states:_____, _____ and _____.

REVISION

TASKS:

1. (CIRCLE THE CORRECT ANSWER. ONLY ONE ANSWER IS CORRECT)

Water is a liquid:

(1) Without colour, taste and smell

(2) Of a grey colour, pleasant smell and sour taste

2. (FILL IN) Water _____ a shape has got/has not got

3. (FILL IN) Water in nature is found in three states _____, _____ and _____.

4. (ANSWER THE QUESTION) What is a thermometer?

_____

5. Why does the laundry dry faster when the weather is warm?

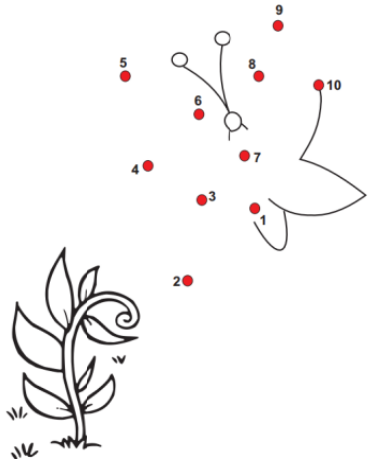
_____

_____

CHECK YOUR ANSWERS!

HAVE SOME FUN!

CONNECT THE DOTS FROM 1 TO 10 AND YOU WILL GET AN INTERESTING PICTURE.



The project is available to the wider population in city libraries (Fig. 11) where they can attend exhibitions and workshops run by students. In the past academic year, 12 workshops were organized in three primary schools and 6 workshops were held in city libraries. In addition, five exhibitions were staged, two in libraries and one in each school. Finally, all project holders (three schools, 150 students and three teachers) together visited ZOV (Zagreb Wastewater Treatment Plant) where sampled water was analysed. For the students this group visit marked the end of the project.

The teachers presented the project, as an example of good teaching practice, at the 25th HSKIKI (Croatian Meeting of Chemists and Chemical Engineers with international participation) held in Poreč on April 23, where new ideas and suggestions for cooperation were put forward.

4. Conclusions

The initiative was launched by Marijana Magdić, from Sesvetska Sela Primary School, where the project has been implemented for three years. Mirna Coljak and Vlatka Husetović from Jelkovec Primary School and Grof J. Drašković Primary School were both delighted to join the team. Together we designed the project which was simultaneously and identically carried out in all three schools. Other schools expressed their interest, so the project is sure to continue and to expand.

The long-term goal of this project is to introduce children to scientific approach and methodology. Working in this way, actively taking part in research, students master the stages of research and thus simple experiments become irreplaceable at all levels of education. Through active participation and dialogue, students discover cooperative learning and develop skills that will be beneficial in the wider community.

Working on the project students' evidence that the role of an individual is a key one in building a better world: This helps develop their civic skills and attitudes that serve as the starting point for environmental education. The authors have also included students with developmental disabilities in the project assignments. The authors made various adaptations and implemented individual approach with the goal of training students for independent work and life according to their personal abilities in line with the principles of inclusive education. Each student thus receives positive feedback and experiences the joy of success that leads to the development of self-confidence and love of work and learning. Our project lives and grows with our students.

The authors are currently working on brochures that will present the work of our students and help other schools wishing to embark on this particular project or a similar one.

Fig. 11 Photos from the workshops held at the schools and libraries.

Fig. 12 Project participants' visit to ZOV (Zagreb Wastewater Treatment Plant).

Fig. 13 Project coordinators.

Acknowledgments

Our special thanks are extended to all our students as this project would not have been possible without them.

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