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CORELLATION OF MATHEMATICS AND PHYSICAL EDUCATION

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Abstract: *The aim of each modern teaching is integrated learning while various knowledge is associated horizontally and vertically. At the Teachers' Training Faculty in Belgrade,*

we have practiced camping of our students at the most remote parts of Serbia where students learn how to survive in nature. They find themselves in various and most incredible situations in which they have to practice mounteneering, swimming, finding food in the surroundings in nature, etc. It has shown that many situations, besides physical fitness and good health, require a solid mathematical knowledge. We are trying to present elementally mathematical knowledge indispensable for survival outdoors, in nature, in this work. These knowledge enable us to orientate without a compass, determine the height of an object , the width of a river, the distance of heavenly bodies, etc. Having in mind the fact that future teachers are on camping, we also point to the aesthetic side of upbringing and education.

We admire mathematical organization of nature in various situations. We point to mathematics present at a leaf of a tree, honeycomb of bees, animals' growth , etc.

Key words: *mathematics, physical education, camping, resourcefulness /surviving outdoors.*

Introduction

The aim and tasks of physical education teaching are not realized exclusively during instruction (by regular time-table for physical education and anticipated physical activities that last 45 minutes in essence), but also through extracurricular activities which are especially important for the students.

If we start from an assumption that one of the basic tasks of physical education is to teach an individual to practice permanently and in free time, on the basis of personal determination and conviction, then it is clear that this task is easier done through the forms of work in physical education for which the students were determined voluntarily . The subject matters which cannot be realized through a class lasting 45 minutes are important for physical education instruction as well.

" The essence of extra curricular activities is the same as at teaching physical education. Doing the tasks and reaching the aim of physical education by practicing bodily movements – exercises" . (Martinovic, 2005:466)

Going outdoors becomes a practice to many people after one going out for a breath of air only, in green forests and fields or along a river.The very staying out in nature can be realized in many ways, and one of them is camping , organized by the Teacher Training Faculty in Belgrade for its students, within elective subject ' Outdoor activities'. The aim of outdoor activities is to introduce better the students – future teachers and tutors into the possibilities and contents which could be offered by organised staying outdoors, in nature, with basic aim to pass on gained practice and experience to youth they will work with in near future during their professional work.

Camping , as a specific form of holiday and recreation in our conditions, has occurred recently. It has especially become popular when so called selective tourism occurred , when one is in the position to choose the mode and place of one's staying , when the need to explain the forms of staying in nature in more detailed way occurred , and especially camping.

In order to do the tasks we are facing successfully, while at camping, elemental mathematical knowledge is indispensable as well . A simple mathematical device will enable us to admire the natural order , as David a psalmist did in the 19th psalm, saying : ' The Heavens speak glory of God and heavenly sphere is his hands' work.' Knowing what kind of mathematics is hidden in a leaf 's or a plant's growth… students will like and understand the nature, where a pedagogical aspect of camping is certain. A simple mathematical device, adopted by students at mathematics lessons , is necessary for orientation and surmounting obstacles in nature. Only with elemental mathematical knowledge, along with physical and health preparation , it is possible to surpass all the obstacles we are facing at the camping successfully.

The task of our work has been to point to necessary functionality of acquired knowledge before and during the studies and their inevitable correlation. The stress is laid on knowledge of mathematics and physical culture.

Mathematical order in nature

While being in nature, we observe it as artists and scientists. We find regular geometrical figures in it, what will increase our attention and more profound experience in everything that surrounds us. If we observe leaves, trees and fruits, we come across the most various polygons (triangles, quadrangles, pentagons, etc.) Thus, for example, we find regular triangle in the cross-section of a Colchicum fruit. A circle could be found in the cross- sections of tree trunks, leaves , at throwing pebbles in the water ,etc. Speaking about polygons and noticing them in nature, we can remind of historical tasks on construction, for example, pentagon, quadrature of the circle, etc. We give our camping a wider, cultural dimension in this way. We find algebraic and transcendental curves in the nature. We should mention spirals that we meet on snails' shells , sunflower, etc. If we observed a snowflake by microscope , we could notice wonderful six-pointed stars with the most various forms of points, and at the same time, almost no identical forms . Their beauty and regularity cannot be imagined even by the wildest imagination. A pentagon is found in arrangement of seeds in apples and pears, when we cut them in halves. The situation is similar with their flowers. All these facts were mentioned best by Galileo Galilei (1564-1642) , as he used to say:" Nature is a vast book in which the science is written up. It is always open in front of our eyes, but a man cannot understand it unless he previously learns the language and letters it is written by. It is written by the language of mathematics, and its letters are triangles, circles and other mathematical figures''.

Every object in nature has its form, position toward other objects, and it takes up a part of the space. If we abstract these three features, we come to an ideal geometrical body. We shall notice its surfaces which could be flat and crooked, lines (straight, curved, closed, open), segments of a line, points,… Camping is the right place to return back to Old Egypt and imagine the origins of creating geometry from the nature. After the flood by the Nile , the Egyptians had to measure the ground that was in the shapes of various geometrical figures. In this way they came to the notion of a geometrical figure and its surface. The knowledge acquired in such a way was called geometry. The word geometry means measuring of the ground (from Greek word γεωμετρια).

While objects in nature are regular and irregular, symmetry accompanies almost all living creatures. If we observe arrangement of leaves on a stalk, we will find many facts interesting for mathematics. The leaves at some plants are arranged in circles at the stalk's joints, and the leaves along the stalk are arranged in spirals and symmetrically at some other plants. The Pythagoras's triangle (length of the sides 3,4,5) is found on a dry leaf of globeflower and Japanese cypress (Doci,2005:17). Not to mention the spirals and golden cross-sections of shells, fish and crabs . We find here golden rectangles and squares. Fish also contain golden cross - section and the Pythagoras's numbers in the most varied ways. (Doci, 2005:68-69). A serious mathematical discussion about arrangement of leaves on a stem leads us to a golden cross-section, numerical progressions , chain fractions, and much more of it because we need to know advanced mathematics. However, we are on camping, and we should always develop love and admiration toward natural phenomena , thus it is sufficient to deal with these phenomena just superficially as well. Golden cross-section (Divine proportion) is the greatest harmony which is seen everywhere in natural conformity. All that is divided by golden cross-section is beautiful as it is adopted to the features of our eyes. If we divide a whole into two parts in such a way that a greater part refers to a smaller one as the whole to a greater one, ten we get golden cross-section. Many flowers have the shape of a five-pointed star (a regular pentagon) in nature. For example, it is a case with azalea , bellflowers and dog rose flowers. Ratio between the distance of two opposite and two adjacent tops on a flower equals a golden proportion. More elaborate mathematical device, which is omitted here, can show that arrangement of leaves on a stem contains within itself Fibonacci's (Fibonacci, 1180-1250?) progression (1,1,2,3,5,8,13,21,24,..., each member equals the sum of the previous two), golden cross-section and many more mathematical laws (Sevdić, 1965:27-36; Čanak, 2009:118-119). Golden cross-section is also found in a field chamomile flower pattern. Sunflower seeds are arranged along logarithmic identical angle spirals that move in opposite directions. We find Fibonacci's progression and golden cross-section in the number of seeds per spirals and ratio of number of seeds in one and the other direction of spirals. Number of spirals at most of average size sunflowers is 34 and 55. These are Fibonacci's numbers (f9, f10). At large flowers, that number is 55 and 89, also Fibonacci's numbers (f10, f11).

We also come across hives and bees in nature. It is the opportunity to say something about hexagonal cells of honeycomb where a bee moves. From the initial position, a bee comes across to the next ,adjacent cell, moving always to the right (up-straight-left). Number of paths, from the initial point to certain point *n* equals $n+2^{nd}$ term of Fibonacci's progression. A bee builds its honeycomb in such a way that it can store maximal quantity of honey in minimal space with the least consumption of wax for the construction.

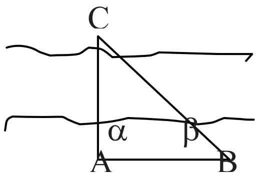
Mathematical device helps in overcoming obstacles in nature

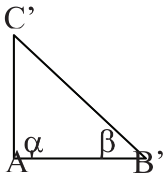
While at camping, we oranize going to mounteneering , we explore the surroundings and overcome unknown obstacles. It is especially important to know how to measure the height of the rock that interposes and blocks the road, the width of the river that we should swim across, the length of the road,etc. Elemental mathematics helps us here, knowledge of lengths of some parts of our body , a rod, shadow, etc. We will remember an anecdote how Tales (624-547 B.C.) measure the pyramid of Kheops. He was asked by the Egyptian priest to measure the height of the great pyramid, Tales took the advantage of a clear day, laid in the sand and left the impression /trail of his body, stepped on one end of the impression and waited till the length of the shadow coincided to the length of the trail, i.e. impression of his body in the sand. At that moment the height of the pyramid was equal to its shadow. But, Tales did not have to wait for the length of the shadow to coincide with its original. He was able to count the ratio between instantaneous length of the shadow and the length of the original. The Tales theorem application is even more sophisticated through proportion (Sevdic,1965:41). Of course, there are entirely elemental mathematical devices to measure a height of, lets say , a tree if the foothill is not accessible.

We come to a river and we want to swim across it. By simple technique, almost without mathematics, we measure the width of the river. We put out hand above the eyes, as when we protect from the Sun, in such a way that we see the spot to which we measure the width of the river by our eyes below the hand. Now we have a rectangular triangle, one leg is the distance from the ground to our eyes, the other is the required distance. Without moving the position of our hand, we turn left, right or towards the land, to the position more convenient for measuring. We notice the farthest spot that we see below the edge line of the hand. We measure the distance till that spot and that will be the width of the river. Although it seems there is no mathematics in it, it is present, however. It is an opportunity for the students to remind of the knowledge about congruence of triangles. There are some other, simple ways of measuring the width of the river, while the proportions and Tales's theorem , and sometimes elemental knowledge of trigonometry. By these simple devices it could be determined:

1. The distance between point A and C which are divided by the river, and point C is visible.

We shall determine an arbitrary point B and measure the length AB, as well as the angles α and β. We construct the triangle A'B'C' on the river bank. Now the distance A'C' will present the width of the river AC.





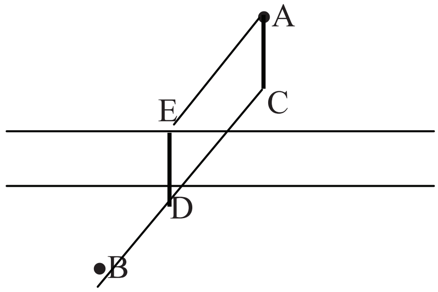
2. The distance of the point A from the point B, if the length AB cannot be measured directly.
3. The distance of the point A from the point B, if some obstacle lies or is located between them, a swamp , for example.

There are many more situations in nature which can be overcome by mathematical device, but we do not quote them in this work.

When we are at camping, we install tents. It is an opportunity to occupy with and amuse ourselves with their mathematical features. Except simple problems, such as calculation the surface and volume, there are interesting problems about tents in the field of minimum and maximum. If the students carry one tent flank each, several of them join and make the tent and stay in it. With the help of mathematics, we will get the answer to the question: Is there, perhaps, the greatest value for the tent's ground size and some greatest value for the value of volume dimension? Maximal values can be searched at arbitrary combination of wings, shape and size of the tent.

We also cross the bridge on the river, and it is an opportunity to think about it. There are two places A and B on different banks of the river. The question is : where exactly to build a bridge so it will end vertically (at a right angle) to the river banks, and places A and B would be connected in the shortest way?

The solution can be seen in the picture. From the point A we draw a segment of the line AC, vertically to the course of the river. The line AC is as wide as the river. The bridge should be constructed at the point D, i.e. where a segment of the line BD cuts the river bank. It is easily shown that every other way from A to B is longer that this one.



Wider knowledge includes geography as well. Knowing how to read a geographical map is of great importance for orientation. For reading maps and determining position, direction and course of movement, it is indispensable to know mathematics, as well as usage of mathematical equipment for reading. Students also should be instructed how to orientate through reference gadgets such as a watch, rings on a tree, position of the stars, moss on the trees, position of temples and monuments on cemeteries ,etc.

As a meter is not always at hand, we should know measures of our body. Firstly, everyone should know the length of one's step. If one does not know that, one could use the rule that the length of a grown up man's step is equalled by half the distance between his eyes and feet. Another rule , which can easily be proved mathematically, says: A man walks as many kilometers per hour as he makes steps in three seconds . It is useful to know the following rules as well: a meter is approximately equal to the distance between the end of one aside fully spread arm and the opposite shoulder. One meter also equals approximately the distance of 6 spans (nine inches) between the tips of the thumb and index finger spread as much as possible. For other referent measures , ask for Dejić , 1995:156.

While taking a rest

After a busy day, in the evening, by a bonfire, we can turn back to mathematics again, without being conscious of that. In starred nights, it is always interesting to wander off to the classical period when there were no modern observatories , airplanes and satellites, but the wise scientists measured the distances between the Sun, the Moon and other celestial bodies from the Earth by simple mathematical devices. Perhaps the story about Eratosthenes (275-19B.C.) who measured the length, of the Earth's equator, without going around the Earth, as a matter of fact, without going anywhere from Alexandria where he lived (Dejić M., Dejić B.,1995:156).

Number is a quantity of something, and we should always give the answer to the question "How much /how many?" when we are camping. At leisure time, students play chess. It is a good opportunity to find the right answer to the question how many kernels of wheat could be placed on a chessboard, if we put one kernel on the first square on the chessboard, 2 kernels on the second, 4 on the third and so on, on each new square we should put double quantity of wheat that on the previous one. The numbers of wheat kernels on chessboard squares make geometric progression , and their sum is of 20 ciphers.

Someone picked up a dandelion and blew into it. If that dandelion had 100 seeds , and a new plant would grow out of each one, in the second year there would already be 100 new dandelions, in the third: $100 \cdot 100=10000\ldots$ in the tenth year there would be 10^{18} . Further , we can count how many dandelions there would be on each square meter on the globe, and where other plants would be placed. The number of insects, animals, mammals, etc. can be counted in the similar way. As a matter of fact, great numbers are all around us. Just have a look at the stars in the sky, numbers on tree leaves, distances to celestial bodies ,etc.

Even while we open a can of cylindrical shape, we can discuss about the problem, how to make a can of circumference given in advance with the least consumption of sheet metal.

Conclusion

Modern men live in cramped quarters surrounded by technique, therefore look ever more for free space in nature and outdoors with as favourable micro climate as possible, what is enabled , in addition to everything else, by taking into consideration and application of physical culture. Physical culture brings a man closer to nature, what is very important. Getting closer to nature should be also understood as approaching of one to oneself and to generic essence contained in its own motion. It must not be forgotten that a man is not a master of the nature, but its product and integral part. Modern living conditions , rational life and running after money, for greater production and rational life determine to a great extent the possibilities of being occupied with physical culture (temporal above all). Practicing physical culture is also , in addition to everything else, a matter of free time, determined for doing cultural activities.

“ A man has a special place in the world of nature. He has made ‘helping devices’, used them as his lengthened extremities , in the sense of prolonged brain activity. A man succeeded in adapting nature to his own needs to a great extent , by his work and activities , and he also does that presently in a modern way. Moving his own body is a primary device which a man uses in order to express relation of his own being and the world he lives in (Martinović, 2005:30).

Presently, integrated learning and application of knowledge are factors that cannot be avoided in any single segment on any level of education. We have integrated two seemingly disparate fields, mathematics and physical education. We demonstrated multilateral advantage of mathematical device and its concrete application at the students’ camping. The students have practically seen and learned how to orientate without a compass, how to determine the height of an object, the width of a river, the distance of celestial bodies, etc. Admiration to mathematical order in nature and application of mathematics at leisure time have not been omitted either.

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