Experiential phenomena as experimental activities in science laboratory based on the human body – Four cases

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Abstract. *In order to motivate the trainees participating in a science laboratory and to cultivate through this, basic skills on laboratory techniques, we developed four interdisciplinary experiential activities. In these activities students estimate, measure and/or calculate using sensors and other devices certain biological characteristics of the human body such as: heart and human respiration rate, human response time, acceleration of a human punch, body's temperature after exercise and during woman's period and factors that influence oral hygiene.*

Keywords. experential, human body based experiments, interdisciplinary.

1. Introduction

The main scope of this paper is to elevate an idea of hands on science experimental procedure: the use of the human body as a means for experiential interdisciplinary activities. These activities can easily be placed under the general umbrella of Science Technology Society (STS) teaching. STS education addresses learning of science concepts in the context of real life experiences and with application to real life problems and issues (Lutz, 1996) [1]. The human body and its functions are easy to understand and affects and interests every human being that is the main reason it can be a good vehicle of promoting students to be involved with measurements in a laboratory procedure. Thus we develop four experimental activities: a. counting heart and human respiration rate using a microphone attached to a computer. b. calculating human response time when a ruler falls and the acceleration of a human punch, using a range sensor.
c. counting body's temperature in various circumstances: after body exercise and during woman's period using thermometers and temperature probes and d. oral hygiene with the use of a PH sensor.

2. Methodology

For the whole intervention we propose the scientific /educational method which is a pedagogical approach of the historically recognized scientific research method. That method through which scientist, researcher, man, had research, is researching and will continue to research natural world [2]. In every activity we used software, which developed under the simplest form so that it can be used for any other similar procedure to support it. The software acts supplementary giving in every step of the methodology the necessary elements such as videos and pictures, which are used to activate the students and to give them the appropriate guidance through the experimental procedure. The way the software is used can be altered according to the kind of the laboratory that is chosen each time. The software provides also the necessary worksheets that the students used to follow the scientific / educational method. The worksheets were developed under simplicity and directness of executing specific acts.
The first implementation took place with students of the Pedagogical department of the University of Athens. These students are

future teachers so they should acquire certain experimental skills and general knowledge about human body and health.
Generally speaking that kind of procedures can be implemented in the two last grades of primary education, to the last grade of high school according to the curriculum, mostly in the educational zone which is known as the interdisciplinary activities zone or as introductory lessons to science experimentation. That kind of procedures could familiarize students with sensors, computer software and experimental practice.

3. Experimentation

3.1. Counting heart and human respiration rate using a microphone attached to a computer

In many researches it is clear that most of the students confuse the cardiac rate with the breath. Although both functions are interdependent the rate of the breath is not identical with the rate of heartbeat. In order to establish this kind of difference we used a simple way of measure the heartbeat and the rate of the breath (without using expensive measuring tools). Using a microphone that is attached in a certain point on the neck, we measured, through a program of processing sounds (e.g the shareware software Goldwave) the heartbeat. An image taken from this software is given below.

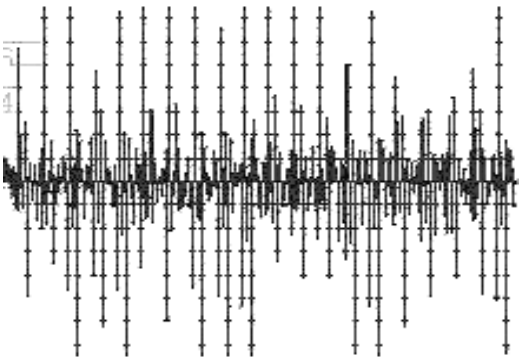

Figure 1. Heartbeat of a student

If the sound is not clear enough using the previous mentioned software (or any similar to that) it can be cleared so that the sound is heard loud and clear (experential). From this graph students can measure the cardiac rate (measurement/calculation). After that students put the microphone near the nose and an image like this will print to the screen:

Figure 2. Rate of the breath of a student

This kind of software depends on timeline so it is easy to estimate the heart and breath rate from these graphs. In addition using the microphone we can measure the rate of the breath before, during and after certain activities, in order to correlate them with the heartbeat. We can also use people who are smokers or people who don't exercise regularly in order to underline the bad affects to our health in these circumstances. The kind of the activities that finally are adopted depends on our didactic approach and the school level.

3.2. Calculating human response time when a ruler falls and acceleration of a human punch, using a range sensor

Further more an activity we suggest is that one which uses a range sensor that measure the distance of a moving body. In this activity we use a ruler that falls and we have placed the sensor in order to measure the change of the height of the lower part of the ruler. The time-height graph that the sensor's software is producing is the one of Fig. 3.

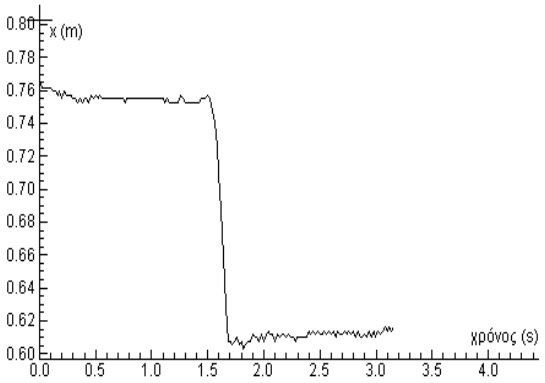

Figure 3. Catching a fallen ruler…

The experimental process is carried out by two people. The first person holds the ruler in a certain height above the sensor and the second person is ready to catch the ruler when it falls (the activation is given with a sound). In that way we measure the time one person takes to react so we can discuss a lot for the way the human brain works

To enrich the reports concerning the human brain but also to deal with experimental procedures relevant to the velocity and the acceleration, using the same sensor we propose the measurement of the velocity and the acceleration of the human punch. One graph measuring distance and time has the formulation of that in Fig. 4

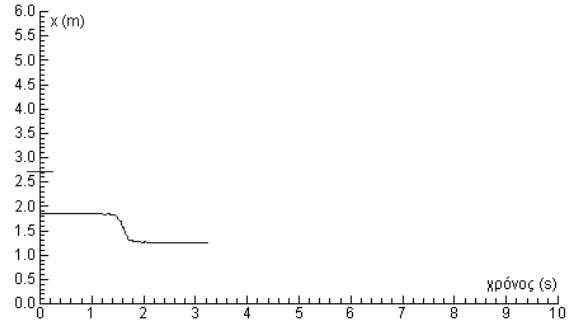

Figure 4. Graph of a human punch

Further more we can compare two graphs from two students with very different body shapes and expand the possible results in specific Biology and Physics lessons.

3.3. Counting body's temperature in various circumstances: after body exercise and during woman's period using thermometers and temperature probes.

In this activity is attempted to measure the human body's temperature in many different situations. The temperature in a laboratory can be measured using sensors or digital home thermometer. Then the measurements are recorded and appear in graphical representations like this one in Fig. 5. We can also measure the temperature of a number of people and extract specific conclusions through dialogues about the variation or not of the experimental data.

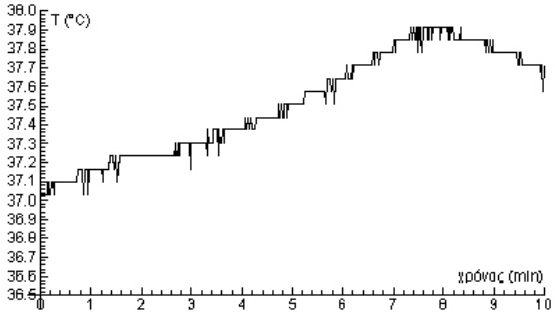

Figure 5. Body temperature

In the next experiment we propose (in latest grades) that the girls can measure their temperature during their period. This is something that apart the other (science) benefits can help the students, not only girls of course, to socially mature and to stop having taboos about human body through a scientific procedure. Furthermore the measurements, in general, outside laboratory can help students to introduce in every day life the scientific method and with particular references they could estimate the value of the measurement.

3.4. Oral hygiene with the use of a PH sensor.

Even though the PH sensor is constructed to measure the PH of chemical solutions, through specific procedures can help students to estimate how acid or basic is their slaver. Generally speaking our slaver has specific PH that remains steady and varies after drinking or eating and there are many

factors that can influence the PH in our mouth. In many circumstances the reason for having problems with our teeth is what we drink or what we eat. So it is good to know what affects our oral hygiene. In addition the PH of our mouth indicates more for the whole health of a person. For that, we organize experimental procedures using a PH sensor and appropriate worksheets. Maybe the whole procedure sounds difficult to be made but finally it is less difficult than it sounds and can help the students to understand and interconnect these factors that can give them good health.

4. Conclusions

The most encouraging element of all the procedure was the huge interest that students showed from the beginning of the experimental procedures. It is also good to be mentioned that students with low expectations of themselves appeared to be more skilful in that kind of experimental practice than we expected. Most of the problems encountered concern the use of the sensor's software but this is something we were expecting as soon as the implementation was limited in time. We can overcome that kind of difficulties with the extensive use of sensors and software in introductory laboratory. Nevertheless more conclusions can be extracted if more research take place, but the first elements indicate that this kind of experimental activities can cultivate experimental skills with an easy and pleasant way and help students to become scientific literate members of our society.

5. References

[1] Su Walter Yu-Jen. Promoting scientific Literacy for Future citizens through developing STS activities. Proceedings of the 1st IOSTE Symposium "Science and Technology Education Preparing Future Citizens", Paralimni, Cyprus; 2001, invited paper, vol II, p 182 - 189.

[2] G. Kalkanis, "Which (and How) Science and Technology Education for Future Citizens?", proceedings of the 1st IOSTE Symposium "Science and Technology Education Preparing Future Citizens", Paralimni, Cyprus; 2001, invited paper, vol II, p. 199 - 214 .

[3] Kalkanis G., Educational technology. University of Athens; 2002

[4] Kalkanis G., Educational physics. University of Athens; 2002