

Physics, Radiations and Health

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Introduction

The main substance of this work is to present the results of the approach of Physics relating it to Health contexts, in two levels: as a mean to efficiently reach the students in secondary school, and as a physics engineering last year project.

In these two levels of learning, understanding, and applying physics concepts, we used formal and informal contexts for physics education, since we used from didactic equipment to hospital facilities, therefore exposing the students to simulated situations and to real life events.

The starting point of this study is radiation. Theoretical concepts, experimental set ups, production, detection, effects, uses and applications are some of the topics covered in both levels.

Secondary School level: methodology, results and analysis

In secondary school we worked with a set of 163 students, 15 to 16 years old, in Sciences areas. The purpose was to try to diagnose the interest of these students in the medical uses of physics, using the topic “radiations” that is approached in their normal curriculum in a traditional, non-integrated, way [1]. They were presented an inquiry, with a set of investigation questions, in order to obtain information on their opinions. We present next the results regarding some of questions:

A - Which topics do you find more interesting, regarding radiations?

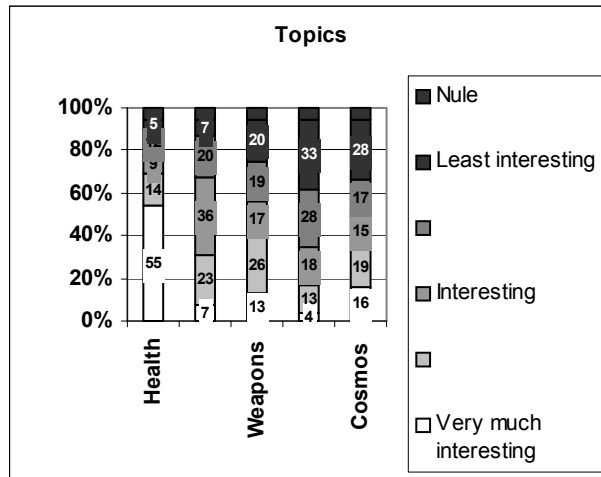


Figure 1: On the horizontal axis we display the options available to the students.

As we can observe, Health is the topic the students elect as the most interesting. But when we invited them to justify their option, the main reasons for choosing Health were:

1. Radiation bad effects (40%)
2. Protection/prevention
3. Health importance / daily life
4. Scientific / technological applications (11%)

So, some questions was proposed, in order to try to understand the conceptions beneath the answers, namely:

B - What do students know about radiation?

From the analysis of the results, we can say that this set of students can differentiate from radiations and energy. For example when they are asked if “Magnetism a radiation?” we obtain more than 80% of “no” answers.

C – What medical diagnosis exams do you know that involve the use of radiation?

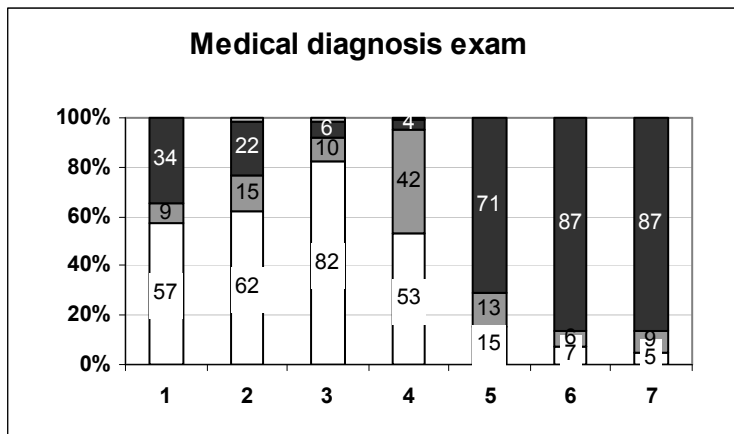


Figure 2: On the horizontal axis we display the options available to the sutendts: 1- MRI; 2 - TAC; 3 - RX; 4 - Ecography; 5 – Fluoroscopy; 6 - Cintigraphy; 7 – Angiography

From the statistics we can say that they are familiar mainly with X-ray exams, as expected, followed by TAC, ecographies, and Magnetic Resonance Imagioly. Also, these are the medical examinations that they associate with radiation, which they also believe, “has bad effects”.

As far as applications/consequences are concerned, 90% thinks that RX are more suitable for diagnosis, and UV, radioactive substances and gamma rays, can produce diseases (>50%). Less than 35% consider that any of these examples can also be used as therapy.

D - What incorrect ideas/misconceptions can we detect?

From a set of several possible wrong ideas that were available, all of them related to sun exposure effects, the most common (>80%) relate to how radiation propagates.

E - How are these ideas an obstacle regarding the correct understanding of danger/risk evaluation?

On this point a very concerning result comes up, because the fear of the consequences seems to influence the degree of probability they associate with the disasters there are most likely to occur, involving radiations.

From the analysis of the answers to the whole inquiry, it is possible to find two kinds of ways of thinking between the students: on one hand, they consider that radiations are dangerous due to the serious effects they produce. This makes the students afraid and this fear leads them to a great interest on the knowledge of radiations effects and protection measures. On the other hand, they consider that the risks involved with radiations are limited, and so they show an excess of confidence in certain safety measures, which leads them to make serious judgment mistakes such as underestimate the penetration power of some radiations.

Apparently these facts arise mostly because of the way the theme is approached on school manuals, and on the lack of misconceptions detection. Nevertheless, much has been done in order to prevent the effects of alternative and misconceptions.

University level: methodology, results and analysis

In this level we appealed to the knowledge acquired in the previous university years, in order to be sure that radiation is “known”. The study begun with a Didactic equipment, on a last year project of a Physics Engineering degree, to characterize the answer of photographic and radiographic films under X-Ray exposure, in order to obtain information from the image on the film [2].

Then we moved to a district Hospital to meet daily situations, namely in radiology diagnosis, and presented a new method to improve early diagnosis of breast cancer, both in an equipment set and in a simulation program.

The purpose is that the future engineer understands that daily words may be used to rigorously speak about and explain science, even in informal learning contexts, and to enable him/her to contribute to the public understanding of science.

These are some of the steps of the strategy that were taken to accomplish the goal.

We began on the University laboratory, with the study of the dependence of the definition or sharpness of images on the size of the focal spot of the X-Ray tube. The ratio of the subject/focus distance to the subject/film distance is an important factor influencing definition, and the conditions for maximum definition are directly related to the penumbra and, consequently, to the “geometric unsharpness”. This can be shown with the interpretation of radiographs taken under different conditions, as in the following figure.

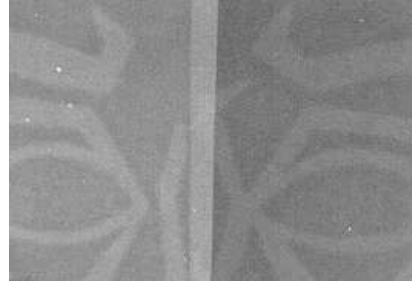
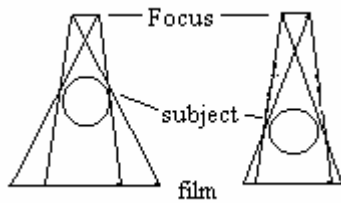


Figure 3: Distance relationship diagram, and penumbra with different distances.

Also, the effect of different exposure times, accounts for the better or worse definition of the data.

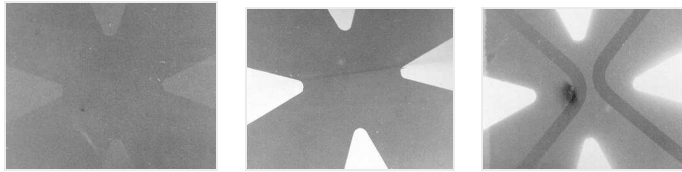


Figure 4: Data obtained with different (increasing from left to right) exposure times.

Being aware of the effects that the acquisition circumstances can have on the final image, we moved to hospital-radiology real context, where the students had to deal with real radiology equipment, and try to minimize some of effects they knew might affect the information. The study was performed on the early diagnosis of breast cancer.

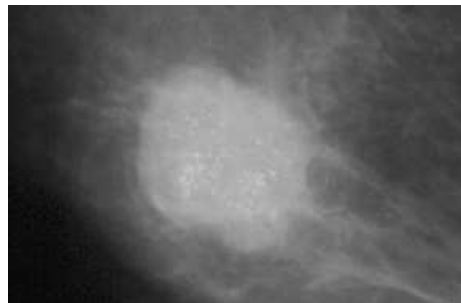
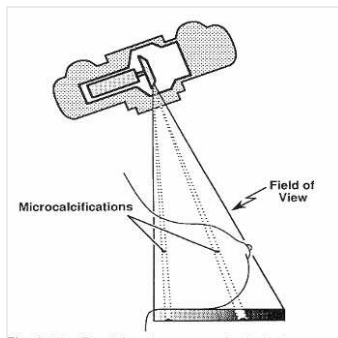


Figure 5: Real hospital context data acquisition system, and distance, definition, “sharpness”, penumbra effects on the image obtained with amplification = A.

Since the main purpose is to be able to make a diagnosis based on the image analysis, it is very important to “manipulate” it in order to increase the definition degree, and avoid an extra X-R exposure. But, on most of the equipments in use, we only can obtain a fixed amplification factor, A.

The project was based on our suggestion of: “reading” the film with a laser, instead of using negatoscopy, and a variable amplification factor [3]. And we present next the results of the reading of the same film as shown previously, but with the student’s suggestion.



Figure 6: Micro calcifications observed with amplification from NA ($N > 1$), on the left, to NNA, on the right, where some degree of optical distortion is already detectable.

Conclusions

The results of this work show that, on one hand, secondary students are very interested in Health issues, have some incorrect ideas that need to be clarified in order to make them better prepared citizens, and it is very important to do it, if we are to improve the public understanding of science. Do we have the teachers to do it?

On the other hand, the bridge between academic studies and real life procedures is successfully overcome, preparing new graduates – in this case on a Physical Engineering degree - to face their first job in a professional and conscientious way. This approach enables the student to easily talk about science in a way that general public does understand it [4].

Further work is underway in both levels.

References

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