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AN INTERDISCIPLINARY MODEL FOR TEACHING THE TOPIC "RECORDING THE CARDIAC AND VASCULAR SOUND", USING THE INTERACTIVE WHITEBOARD

Aneta BUZATU, Daniela STOICA
Faculty of Physics, University of Bucharest, 405 Atomistilor Street, Magurele, jud. Ilfov, CP MG-11, 077125 Romania
E-mail: aneta.buzatu@yahoo.com, prof_dana_stoica@yahoo.com

Abstract*: At the moment, humankind faces global problems that demand an integrate vision towards many phenomena that cannot be studied separately, but only by taking their interdependence into account. Many interdisciplinary fields enjoy a great popularity. The interdisciplinary instruction encourages connections among disciplines by helping students build powerful knowledge schema. Interdisciplinary teaching encourages students to integrate their specific knowledge in a domain in the context of a new problem. Modern technology, like the computer and the interactive whiteboard, helps students develop competencies and skills of interdisciplinary thinking. Thus, there is a tight connection between Physics and Anatomy, with a large applicability in the teaching process. As an example, there is a need for knowledge belonging to the Physics domain to understand the functioning of the heart. The present paper intends to emphasize the connection between Physics and Anatomy by applying the notions regarding the sound propagation considering the heart function. Using the interactive whiteboard and an assisted computer experiment, we have succeeded in recording the cardiac and vascular sound. Relying on the performed measurements, we have determined the pulse rate per minute. It is of the utmost importance that students understand how Physics concepts are applied in the medical field and that the therapeutic and diagnostic tools have their origin in the basic principles of Physics. In the making of the teaching aid presented during class lessons, we have taken into consideration the Cognitive Load Theory, and the implications of a Cognitive Theory of Multimedia Learning.*

Keywords: *interdisciplinary teaching, interactive whiteboard, assisted computer experiment, cognitive load theory.*

I. INTRODUCTION

Physics is a difficult discipline that is most times seen by students as consisting of isolated information with no connection to the everyday practices [1]. This aspect can be explained through the complexity of the school curriculum and through the attitude of the teacher, and if his only objective is to go through this curriculum, he will be less concerned about finding ways of conveying the notions in order to help students build schemas of knowledge. According to some researchers, one reason for the decrease of students' interest in Physics would be the fact that the student is not explained where to use the notions that he has learned in practice [2]. The increase in students' motivation for Physics classes could be realised by interdisciplinary teaching [3]. Interdisciplinary teaching implies the integration of information from different fields in the prior knowledge of students [4]. An advanced understanding of the subject should reflect connections with other fields of science [5].

An interdisciplinary approach, which could be realized by using interactive whiteboards, was created based on the theory of cognitive load and incorporates the multimedia learning principles [6].

II. INTERDISCIPLINARITY TEACHING

Interdisciplinary teaching imposes itself more and more because students perceive subjects isolated one from another and separated from practice. Replacing the already existent disciplines is not a purpose of interdisciplinary teaching. In fact, it assumes surpassing the boundaries between disciplines and the cooperation between these. The purpose of interdisciplinary teaching is reaching the knowledge and objective understanding of reality [2]. Reality is unique and continuous; therefore the division caused by disciplines should be followed by a comeback to the entire original [7]. Interdisciplinarity assumes the open interaction between certain independent contents from two or more disciplines [8]. Interdisciplinary education assumes a series of interactions which manifest through [2]:

-the processing of methods, notions that are specific to some subjects;
-the parallel description of the same phenomena;
-offering necessary notions to other fields.

For example, the circulatory system of the human body can be understood on the basis of fluid mechanics notions; the functioning of the human heart could be understood by applying the model of a pump.

When shaping the instructive material, the teacher must try to correlate the notions that are common to different fields of study and adapt them to students' interests. He must be up to date with the rapid progress of other subjects. Interdisciplinary teaching presents some advantages, of which some must be mentioned:

-focusing the instructive process on the student; conceptual learning; team learning, learning on the basis on projects;
-the contribution to the creation of flexible mental structures;
-supporting students in a meaningful and long-lasting learning by permanently interacting between subjects [8].

Other advantages of interdisciplinary teaching would be:

-the constructivist approach of learning;
-understanding of science processes and key problems of humankind;
-gaining of interdisciplinary skills;
-the discovering and processing of information in the IT field;
-gaining communication skills [9].

III. A COGNITIVE THEORY OF MULTIMEDIA LEARNING

Multimedia involves the presentation of words (like printed text or spoken text) and pictures (with illustrations, photographs, animations or videos). Multimedia learning means the build of mental representations of words and pictures. Multimedia instructions mean the presentation of words and pictures in order to promote teaching, to help students build mental representations [6]. The cognitive theory of multimedia learning is based on dual coding theory, cognitive load theory and constructivist learning theory. According to the dual coding theory the visual information and as well as the verbal one are processed in different processing systems, respectively the visual channel and auditory channel [10].

The idea that every processing channel of information has a limited capacity is drawn from the cognitive load theory [11]. The constructivist learning theory assumes that meaningful learning takes place when the student selects the relevant information, organizes them in a coherent representation and integrates them into schemas of prior knowledge [12]. Due to the severe limitation of the working memory, learning is most of the time difficult [13]. Any cognitive load may limit people's ability of processing and learning new notions. In order to make learning efficient, the teacher needs to take into consideration the decrease of cognitive load by limiting the learning material, correcting the new information according to the ideas that the student already has [1].

The cognitive load's components are: intrinsic, extraneous and germane cognitive load. The intrinsic cognitive load is created by the complexity of the material that is going to be presented and by the grade of interactivity between elements. The germane or effective cognitive load is related to the process of learning or processing the information in order to build mental representation and integrate this representation in long term memory. The extraneous or ineffective cognitive load results from the manner in which the material is presented and is often the cause of insufficient learning [13]. The multimedia environment includes on-line instructions, Power-Point presentations, interactive lessons, interactive simulations, virtual reality.

An important quality of the multimedia environment is the interactivity that may lead to the raise of the student's interest. For example, the use of interactive simulations may stimulate the student to test hypothesis, to check and analyze results [4]. The teacher has to know that it is not the media environment that cause learning, but active cognitive processing by the learners [14]. That is why it is important that the teacher, while he is preparing the material which will be presented to the students, should not resume to present the material not only by word and pictures but also to help the student to process the material in meaningful ways [15].

The Mayer's multimedia theory is based on a set of principles:

1. Multimedia principle: The students learn better from words and pictures than from words alone.
2. Spatial contiguity principle: Multimedia learning is more effective when learner attention is focused not split
3. Temporal contiguity principle: Students learn better when corresponding words and pictures are presented simultaneously rather than successively.
4. Coherence principle: Students learn better when extraneous words, pictures, and sounds are excluded.
5. Modality principle: Students learn better from animation and on-screen text.
6. Redundancy principle: The presentation of multimedia content should exclude extraneous and redundant information.
7. Multimedia learning is more effective when it is interactive [16].

IV. THE INTERACTIVE WHITEBOARD –TOOL USED FOR INTERDISCIPLINARY TEACHING

One of the greatest achievements of technology in education is the interactive whiteboard. It is based on cognitive load theory which includes the multimedia learning [6]. It is a tool used for presentations. It allows the access to all documents from the computer and may use materials from other sources. The interactive whiteboard makes use of pictures and animations from the included gallery possible and allows the creation of new materials and their saving. The interactive whiteboard has an important role in the process teaching offering not only the students but also the teachers a lot of opportunities [17]. The interactive whiteboard allows the integration of an entire resource series such as written texts, sounds, pictures, software, videos, CD-ROM's, internet images and websites while learning. The interactive whiteboard allows interdisciplinary teaching. In the Images gallery, it includes images and animations from different disciplines like: biology, physics, mathematics, geography etc. So, the eye can be presented not only from the biological perspective but also from the physical perspective as an optical instrument, using images from the biology and physics gallery.

The heart can be examined from the anatomical point of view, using pictures and animations from the biology gallery, but it can also be examined from the physical point of view as a pump based on the images from the Physics gallery. The facts regarding the sound and propagation were applied in the following theme: "Recording the heart sounds". The learning of this subject was based on some projects and a computer assisted experiment.

The project is an interactive way of teaching, which usually implies micro research and investigation of the subject of interest [8]. The process of learning from projects assumes gathering information, its process, interpretation and cooperation towards finishing these assignments. The

realization of the project offers opportunities for an interdisciplinary approach. It also facilitates teamwork, it allows the identification of new sources of information- it stimulates the creativity of the students. The Notebook 10 software allowed the students to realize this kind of projects about the record of the cardiac sounds. From a physicist's point of view, information regarding sound waves and its propagation through different environments should be known. The images used from the image gallery of the interactive whiteboard (Figure 1) help the student understand that sound propagation is caused by the movement of environment particles, causing environment layers to compression and rarefaction.

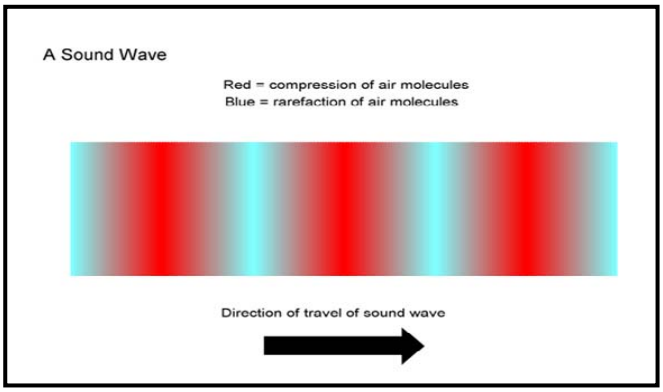


Figure 1. Sound propagation in air

Therefore, a team of students carried out a project about the circulatory system. They used images and animations from the interactive whiteboard software gallery. Animations were used to highlight the stages of the cardiac cycle, insisting on the moments of time in which cardiac sounds are produced. Students comprehend that in a blood vessel, the systole-diastola manifest through a pressure wave which is transmitted and felt in an artery through a gentle press, like a series of beats, called a pulse [18]. The animations used regarding the way a heart functions highlight the fact that audible heart sounds are produced at the opening and closing of the heart valves (Figure 2). The lesson's materials were presented in such a way that they don't introduce additional cognitive load (extraneous cognitive load). Furthermore, the split attention which involves more sources of information that must be integrated physically and not mentally to reduce the extraneous cognitive load was taken in consideration. The images used from the whiteboard software galleries are accompanied by annotations. The animations which presented the cardiac cycle are accompanied by verbal explanations – taking into consideration the modality principle of the multimedia learning theory.

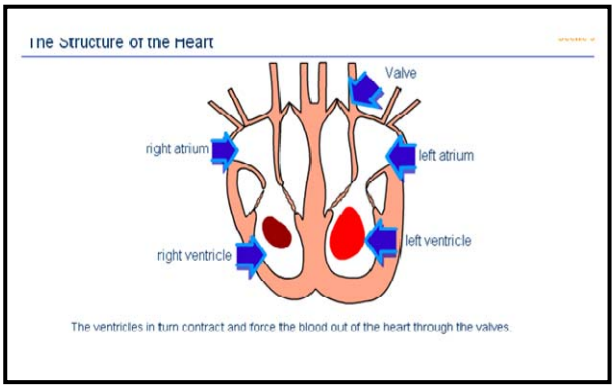


Figure 2. Structure of the heart

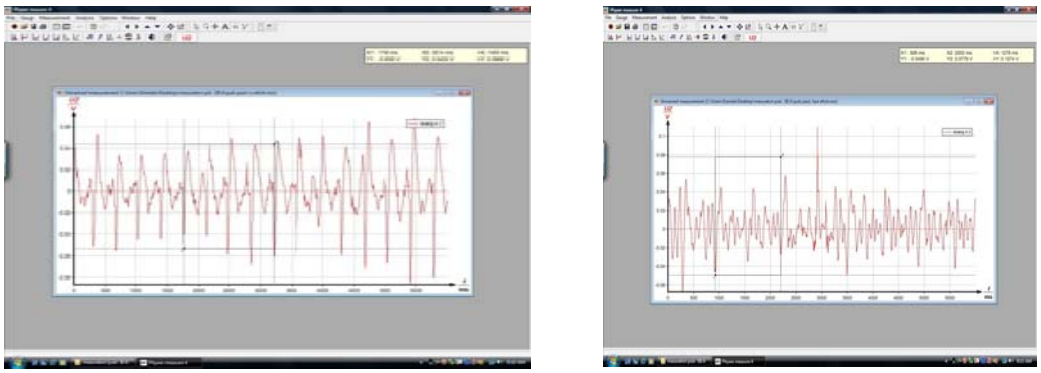
Based on an interactive simulation from the project PHET Colorado (http://phet.colorado.edu/en/simulation/fourier), students were able to learn about the decomposition

of a complex signal in more signals using the Fourier transform. Fourier analysisis is useful in identifying frequency components of a signal [19].

Then, another computer-assisted experiment (Figure 3) was carried out to record the cardiac and vascular sounds. Helped by an acoustic sound, it recorded the pulse (Figure 4).

Figure 3. Student having his pulse taken

That graphic was used to determine the pulse rate. The Fourier transform (FT) was applied to the recorded signals. Therefore, the peaks in a plot of the FT of a signal correspond to the dominant frequency components of the signal (Figure 5) . The sound S1 is produced at the end of the isometric contraction during the systole and the second sound S2 is produced after the isovolumetric relaxation during the diastole [19].



a) b)

Figura 4. Pulse recording a) relaxed; b) during effort

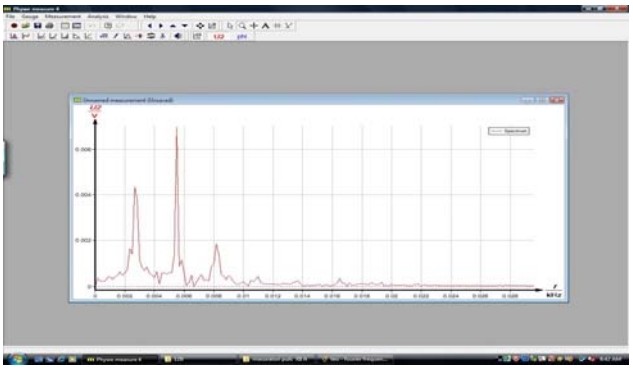


Figure 5. Magnitude of the Fourier transform of the recorded signal

V. CONCLUSIONS

For realizing interdisciplinary connections, the animations help the students to implement the information to an existing framework. To reduce the cognitive load, the information was presented in small sections [4]. The principle of contiguity was applied not only in written texts but also in pictures and animations with verbal texts. The present paper highlights the connection between physics and biology, as well as mathematics, the interdisciplinary approach increasingly asserting as a way of knowledge. Although lacking a professional medical processing of information, the paper may serve as an alternative for diagnosing patients.

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