Methods of introducing Physics concepts, exemplified by two projects, "The Science of Music" and "Landing on Mars "

Cristina Miron[1], Ioana Stoica[2]

(1) Faculty of Physics, University of Bucharest, Romania
(2) Tudor Vianu National High School of Computer Science Bucharest, Romania
E-mail: cmiron_2001@yahoo.com, istoica4143@gmail.com

Abstract

The purpose of this paper is to point out an interactive method to introduce basic physics concepts to younger students. We make our point by appealing to a number of specific software and school projects. This kind of projects can develop links between Physics and Mathematics, Physics and Astronomy, Physics and Economy, or even between Physics and Music, providing outstanding results in the teaching process. The interdisciplinary, transdisciplinary and multidisciplinary perspectives on the methods of approach and exploration and on dropping anchors in the previous knowledge could lead the students to achieve various 21st century skills. We will study the impact made by these school projects upon the progress achieved by the students.

Keywords: Interdisciplinary, Multidisciplinary, Transdisciplinary, School projects, Educational software

1 The interdisciplinary, multidisciplinary and transdisciplinary approach, a necessity of the modern teaching - learning – assessing process

On the one hand, in order to lead the students to achieve 21st century skills, an intradisciplinary approach, within the scope of a single academic subject, just isn't enough. Dropping anchors only in the previous knowledge don't allow students to investigate the complex problems of reality. In order to develop in the frame of a given subject the kind of knowledge able to engender in students the capacity to analyze information and apply it to real life cases, and in order to improve students' understanding and make the learning process more productive, an approach in both an interdisciplinary and multidisciplinary way becomes a must have of the educational process. Interdisciplinary involves the combining of two or more academic disciplines into one activity and allows the students to learn by making connections between ideas and concepts across different disciplinary boundaries. Students learning this way are able to apply the knowledge gained in one subject to another different subject as a way to deepen the learning experience. Interdisciplinary study addresses students' individual differences and helps to develop important**,** transferable skills [Jones, C. 2010].

On the other hand, the new 21st century students' skills require an approach focusing primarily on a multidisciplinary perspective, with the declared purpose of studying a topic from the viewpoint of more than one discipline. A multidisciplinary team approach involving several professionals with their own expertise is important in attaining an optimal effect. The multidisciplinary approach benefit is that people from different disciplines, working together and bringing their own discipline's perspective, will explore the subject in the light of what other fields may have to offer.

A multidisciplinary approach involves drawing appropriately from multiple disciplines to redefine problems outside of normal boundaries and reach solutions based on a new understanding of complex situations. The use of the term 'multidisciplinary' has in recent years been overtaken by the term 'interdisciplinary', for what is essentially 'holistic working' by another name [Jones, C. 2010].

If the interdisciplinary and multidisciplinary approach is related more or less to the content/curriculum, the transdisciplinary approach refers to how science actions merge to create a unity intellectual framework, beyond the disciplinary perspective [http://www.open.edu/openlearn/education/what-are-the-benefits-interdisciplinary-study].

2 Introducing basic physics concepts to younger students from an interdisciplinary and multidisciplinary perspective

2.1 Science of Music project

A lot of students are keen about Physics and Music but they don't make connections between these fields. With that in mind, the authors, together with former students from "Tudor Vianu National High School of Computer Science", created an educational software, *Science of Music*, which offers a journey in the world of music guided by the laws of physics, thus managing to observe the regularities that appear [Moraru et al., 2007].

The software is a useful tool which can be used as an auxiliary material during Physics classes, especially because of its rigorously mathematical explanations, as well as during Music classes, where the teacher can show the students the science behind sounds, and in general by practically anyone who is interested in any of the two subjects [Stoica et al., 2010]. Normally, during a classical lesson the students can achieve notions about waves in an **intradisciplinary perspective, dropping anchors in Physics notions** such as mechanical oscillations, elastic body, motion etc. Using this educational software, the Mechanical Waves topic can be approach in an **interdisciplinary perspective**: one can bring up notion from both Physics and Music in a rigorous, mathematical way.

Moreover, this educational software, containing an interactive virtual piano and a virtual guitar, can lead a student to perform a real investigation, allowing him or her to study this subject using **the Inquire - based learning** method. The student can see, at his or her own pace, how the musical notes are distributed on the piano, hear them while playing the piano, and understand the science behind both the physics and the music.

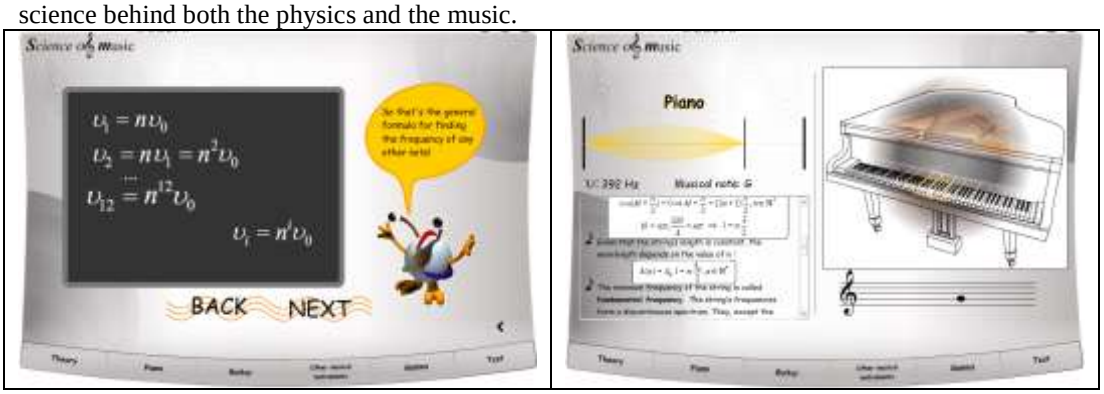

Figure 1. Two Screenshots from the Science of Music *Educational Software*

2.2 "Landing on Mars" project

The purpose of this project is to **design and build a "lander"** that will protect one "astronaut egg" through flying and touching down.

This project **is designed** for schools which adopt curricula focused on Mathematics, Physics, Sciences and Computer Science and for classes that allocate a greater number of lessons weekly for subjects like Physics, Mathematics, Natural Sciences, and Computer Science.

Curriculum areas/ domains involved are Physics, Mathematics, Computer Science, Economy, and Art.

Using different materials, as eggs, paper, rubber bands, plastic cups, straws, balloons, tape, aluminum foil, and scissors, the **students should** be able to:

- design and build a Lander that will protect one "astronauts egg" through flying and touching down;
- follow the engineering design process to design and build a shock-absorbing system out of simple materials;
- improve their design based on the results of test landings [https://www.jpl.nasa.gov/edu/learn/project/make-an-astronaut-lander/].

During the first stage the students will design and build the Mars Lander in an **intradisciplinary perspective, dropping anchors in Physics notions:**

Figure 2. An intradisciplinary perspective

During the second stage, the **students should** be able to **improve the design and** build the Mars Lander considering the science as a whole: after assigning internal roles in the team, a scientist, a designer, an engineer, a communicator, and an economist, the students should set up a research investigation:

- Choose a certain target to reach (the Moon, Mars, Venus or beyond)
- Research the specific conditions out there as compared to the ones on Earth (atmosphere, gravity etc).
- Consider Archimedes's buoyant force should atmosphere exist.
- Consider using a parachute, should atmosphere exists.
- Choose the suited materials from the heat phenomena perspective.

During this stage the students are supposed to design and build the Mars Lander in an **interdisciplinary perspective, considering** the price of materials and the maximum budget available, the same for each team, as well as the manner in which they decide to share their conclusions and results such as a Power Point presentations and the like. Mathematics shall play a major role here too, alongside the fact that the prototypes will be developed using computer aided design.

This project can be put in place during the so-called "Informal Week". The students, working together with their Physics Economy Math Chemistry Astronomy and Informatics teachers each with their own discipline's perspective, will explore the problem in the light of what other fields may have to offer. Thus they could design and build the Lander in a **multidisciplinary perspective**.

All these teachers together with their students will create frames which brought together will form the final project.

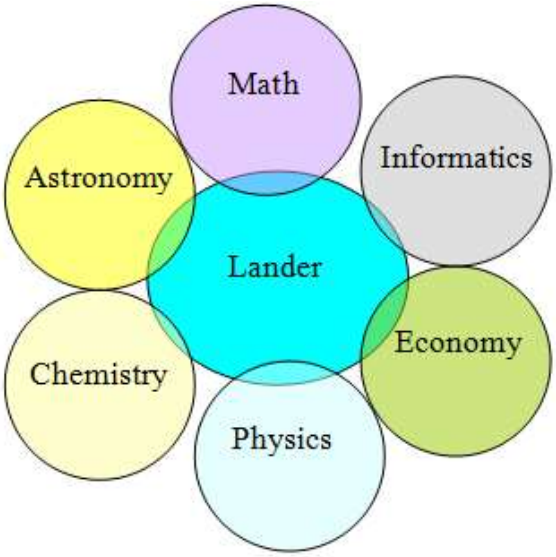

Figure 3. Science as a whole approach

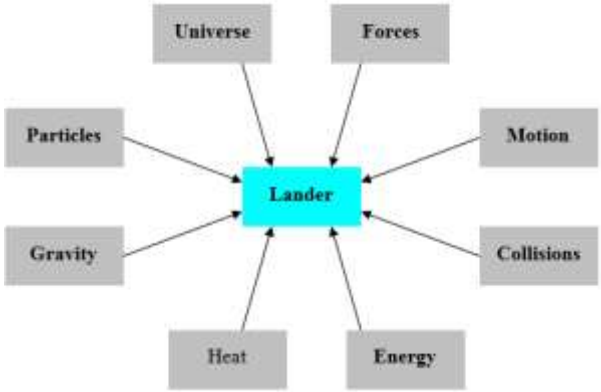

Figure 4. An interdisciplinary perspective.

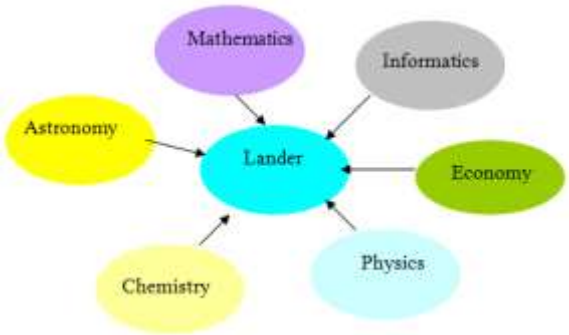

Figure 5. A multidisciplinary perspectives

3 Conclusions

Compared to the intradisciplinary teaching method, an interdisciplinary and multidisciplinary approach allows for a wider range of tools and enhances the students' motivation and, most importantly, opens up opportunities for them to be creative and more independent. As we mentioned before, the interdisciplinary and multidisciplinary study leads to synthesis of ideas and the synthesis of characteristics from many disciplines [Jones, C. 2010]. At the same time it addresses students' individual differences and helps to develop important, transferable skills, and, very important, students studying in this manner begin to consolidate learning by synthesizing ideas from many perspectives and consider an alternative way of acquiring knowledge. As a conclusion, we suggest this type of lessons based on an interdisciplinary, multidisciplinary and even an transdisciplinary approach by broadening of the area of interest, lead to a better students' motivation and to an improvement of the learning skills. This way, the student becomes more self confident and more prepared for a new step in his life, and he can extend his knowledge beyond the school.

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