

Implementation Of Ict Tools In Effective Teaching Of Physical Science In Secondary Schools

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ABSTRACT

ICT is an acronym of Information and Communication Technology. It is a broader term for Information Technology (IT), which refers to all communication technologies, including the wireless network, Internet network, computer hardware and software, middleware, mobile phones, social networking, videoconferencing and any other communication mediums that enabling users to store, restore, access, retrieve, transmit and manipulate information in a digital form (Heeks, 2017). ICT is vital instrument for enhancing teaching and learning across the schools. It offers a wide range tools that leads to the change of traditional teaching process (teacher-centred learning) to an inciting and interactive educational process (student-centred learning) (Muianga, Klomsri, Tedre, & Mutimucuo, 2018). Considering the role of ICT in teaching and learning, a question has been asked "Can ICT applied in Physics education help us achieve the desired goals and objectives?" Scholars agreed that if the ICT is well managed and carefully integrated in Physics education, it assists both teachers and students to easily access educational resources and subsequently improve learning outcomes (Kushwaha & Singhal, 2017). ICT is also effective in improving academic qualities by advancing higher order thinking skills, problem-solving skills and improving communication skills (Ali, 2012).

Key Words: academic, learning, method, principles, skills, students, teaching, technology

Introduction

Physics can tell us more about everything. Whether you like to know why the world moves, or want to understand the laws of the universe and what makes everything tick

– from planets and solar systems to black holes – Physics can explain why things occur the way they do and show us the interaction between phenomena we would not have otherwise seen (Schwartz, Stapp & Beauregard, 2005). Nevertheless, teaching Physics includes more than writing formulas on a chalkboard. It involves developing a learning environment in which students can explore and understand how the matter and energy operate and relate complex science principles to their everyday lives (Ramalingam, Jones, Reba, & Young, 2008). It includes building trust in the ability of student to overcome difficult issues and inspiring them to create a better future for themselves and others. However, despite the benefits of teaching and learning Physics, majority of the students in Africa believed that it is difficult to comprehend some topics as teaching and learning still uses the conventional method (Oakes, Lipton, Anderson & Stillman, 2015).

Advantages of ICTs integration into Physics classroom

In Physics education, ICTs have immensely contributed and facilitated in understanding the abstract concepts, laws, increased students' performance and encourage successful learning through engaging interactions (Nggadas & Ariswan, 2019). ICT is sometime classified as teaching tools which is fundamental in analyzing and visualizing information, perform experiments and communicate results. There are several studies that revealed the use of educational software and other ICT tools in teaching particularly Physics which indeed enhances students' understanding of scientific facts and ideas; providing students with access to richer sources of data and information; helping students to become autonomous learners; and increasing students' motivation (Briones, 2018; (Ellermeijer & Tran, 2019; Nchunga, & Kira, 2016). Other reasons of

integrating educational software and ICT tools in Physics curriculum involve preparing the contemporary students for the industrial work where technologies, such as computers hardware and software, the Internet and other related ICT tools are becoming unavoidable (Okoliye, 2016). The following educational software and ICT tools have been found to be beneficial in teaching Physics.

Educational Software

Education software refers to computer software with the primary aim of self coaching, teaching or self-learning. It is usually developed to simplify difficult concepts, make teaching and learning attractive and motivated. Educational software integrates multimedia content (such as sound, pictures and graphics) and provides users a high interactivity level. Previous studies reported that use of educational software in classrooms and laboratories provides much more effective and efficient environments in teaching and learning Physics. (Moraru, Stoica, & Popescu, 2011). Therefore, the following Physics educational software have been discussed in this study.

I. Oscillations Educational Software is designed for students studying Physics - mechanics with the intent to present an analogous mathematical model. The software has a broader view on oscillations that is extended to optical and heat phenomena. It helps the students with more information on harmonic oscillatory motion, including phasor diagrams, energy, the superposition of perpendicular oscillation, oscillatory motion, chosen from all the fields of classical Physics, optics, electricity, mechanics, and thermodynamics. The effectiveness of this software has been reported in by Moraru et al., (2011).

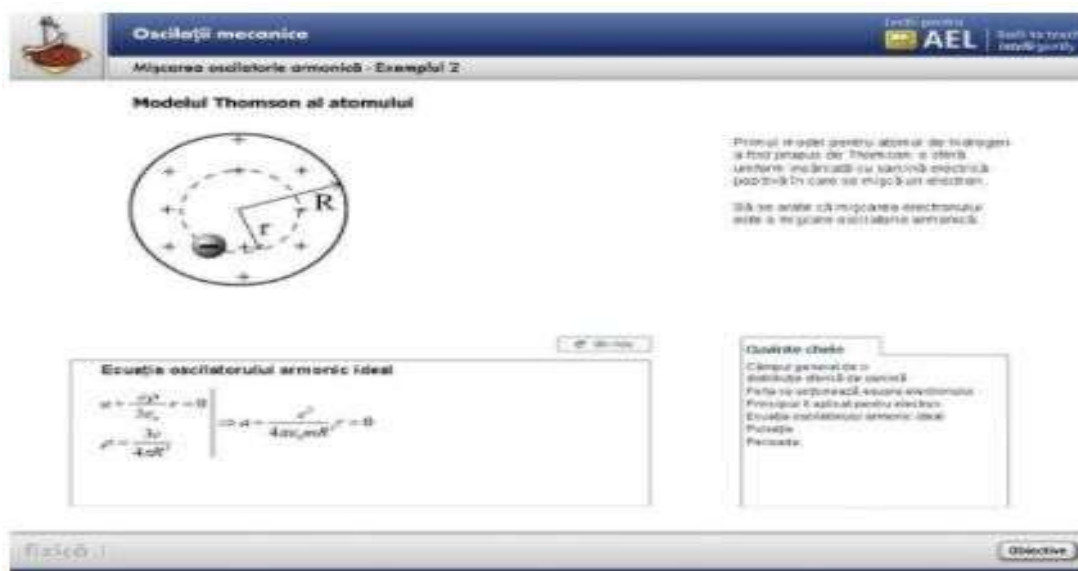


Figure 2.1: Screenshot of Oscillations Educational Software

II. Science of Music Educational Software. The software is used to explain the application of Physics laws in the world of music. It is served as an auxiliary material for students to accelerate class preparation. The application of this software has been recognized as a tool for helping students to comprehend the mathematical laws and practical application of Physics in music.



Computer Simulation

Computer simulations are applications of special interest in teaching Physics because they can support powerful modelling environments through active participation of students. Computer simulations provide a broad range of possibilities for ideas and processes to model. It offers a connection between the previous experience of students and the learning of new physical concepts, helping students with an active reformulation of their misconceptions to improve scientific understanding. For example, teaching of trajectory motion in school Physics labs is difficult since it demands from students' adequate experimental skills, as well as skills on using stroboscopes. The simulation through interactive is an alternate methodology that provides distinct teaching and pedagogical advantages. The stroboscopic representation of a kinematical phenomenon and the simultaneous display of the position and velocity offer an open environment where students can experiment, research the physical rules, make assumptions or predictions and draw conclusions. To understand the related laws and principles of motion, they can replicate their experiments as many times as they need. Students can easily adjust either the sphere's mass or the constant of gravity and observe the effects on the computer screen immediately. They are primarily open learning environments that offer students the chance to:

- i. investigate phenomena that are difficult to encounter in a classroom or laboratory environment due to complexity, technicality, safety, cost and time
- ii. use a range of representations (images, animation, graphs, vectors, and numerical data displays) that are helpful in exploring and understanding the underlying concepts, relationships, and processes
- iii. isolate and control parameters and thus allow them to understand the interactions between physical concepts, variables, and phenomena
- iv. build their knowledge of phenomena and physical laws through a hypothesis-making method and testing of ideas.

Fundamentally, using computer simulation techniques, a student of Physics can analyze, how far succeeded in approaching the actual result while doing an experiment in laboratory (Jimoyiannis & Komis, 2001).

Multimedia

The term "multimedia" is the field concerned with the computer-controlled integration of text, graphics, drawings, still and moving images (video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally (Fiolhais & Trindade, 1998; Meixner, 2017). In other words, it is a media that uses multiple forms of information content and information processing. Research showed that multimedia has positive implication especially in the field of education (Fidan & Tuncel, 2019). Teachers use the media to visualize and simply teaching and learning in the class. Furthermore, interactivity is heightened by the possibility of easy feedback; it is flexible and digital; therefore, it can easily be changed to fit different situations and audiences (Xie, 2018).

The integration of computer interactive multimedia in effective learning helps students to improve their understanding in various concepts of Physics (Kohnle, et al., 2012; Dega, et al., 2013). Interactive multimedia can visualize, simplify and helps students to understand abstract concepts on optics, kinematics, heat transfer, quantum mechanics and thermodynamic. This is stated by Liu (2006) which states that abstract concepts such as the motions laws and gas laws are more easily understood by using multimedia. Doyan and Sukmantara (2014) reported that learning with an effective interactive multimedia enhances the mastery of concepts such as work, energy, and power. Based on the literature review, it is convinced that the use of interactive multimedia using simulations, movies, diagrams, graphics, animations, and sounds plays a vital role to help visualize and simplify abstract concepts that students cannot comprehend (Hakim, Liliyasi, Setiawan, & Saptawati, 2017). In addition, the power of interactive multimedia is to provide opportunities to study the learning material at any time, respond quickly, develop creative thinking, motivate and develop their interest and encourage curiosity to conduct investigations in Physics.

Virtual laboratories

Virtual laboratory is an interactive environment without real laboratory tools meant for creating and conducting simulated experiments (Syphas & Kalles, 2018). A virtual laboratory is one where the student interacts with an experiment or activity which is intrinsically remote from the student or which has no immediate physical reality. It provides students with tools and materials set on computer in order to perform experiments saved on CDs or on web site (Babateen, 2011). Nedic, Machotkd, & Najhlsk (2003) explained other benefits of virtual laboratories which include protecting students from the dangers they face during while conducting some dangerous laboratory experiments. It eliminates the need to deal with toxic or radioactive chemicals and other hazards such as electrical connections; ability to display very accurate phenomena and results that may not be measurable using simple laboratory tools and that require complex and expensive equipment; help students and teachers study and prepare laboratory experiments at any time and place; the student is able to conduct the same experiment several times according his/her ability to absorb the information. This is generally difficult to provide in a real laboratory in the case of limited

material and the lack of equipment in proportion to the numbers of students; and the student is given the opportunity to control the inputs of the experiment, change the different transactions, and observe the changes in the results without the existence of a supervisor and without being exposed to any risks. For instance, several studies have been carried out on the effects of virtual laboratory on students' achievement. Falode and Onasanya (2015) argued that virtual laboratory package Hooke's law, simple pendulum and momentum experiment in secondary school Physics curriculum. Similarly, Gambari, et al. (2012) in another study found that students taught Physics practical using virtual laboratory strategy performed better than those taught using conventional laboratory method. Tuysuz (2010) conducted an experimental study on the effect of using virtual laboratory method in Physics practical class and reported that students' skills, understanding and achievement had significantly improved.

The popularity of natural sciences and technologies - especially physics - as well as the interest in those fields are being declined in the schools worldwide from year to year – as reflected by research studies in pedagogy. The main contradiction is however, that the world of the 21st century cannot be understood and governed, the main global challenges cannot be handled well without a basic knowledge of natural sciences.

In the first part of my research activity, I studied the students' attitude to physics, their motivation, and their IT knowledge. Therefore I verified 9 hypothesis by questionnaires. 17 schools in Hungary and 2 abroad with altogether approximately 900 students have filled out the questionnaires between 2002-2003. As a result of the survey it has become clear that physics classes have to be made more colourful and interesting, if we want to let our students leave the secondary school with high level and applicable skills in physics, and with an advanced knowledge in natural sciences. To turn classes more interesting it is necessary to take advantage of the opportunities offered by IT and multimedia. In this process it is highly significant to use an interdisciplinary approach. Reaching the target is not easy but it is possible by applying complex methods.

In the following we give an overview of methodology and ICT tools used to turn classes more interesting, and to increase motivation of the students.

Multimedia and its elements

"Multimedia is any combination of text, graphic art, sound, animation, and video that is delivered by computer. When you allow the user – the viewer of the project – to control what and when these elements are delivered, it is interactive multimedia. When you provide a structure of linked elements through which the user can navigate, then the interactive multimedia becomes hypermedia" [4].

Optimally all physics classes should include the following: real hands-on experiments, demonstration experiments performed by the teacher, simulations, embedded videos, or other new technologies.

Multimedia and ICT used in education

Nowadays there is an enormous pressure on the schools from the society, and from the media to ensure that students are competent in the area of learning technologies. The majority of the teachers tend to change their attitude and introduce new ICT tools and technologies into their physics classes. Many international projects, - several ones coordinated by the European Schoolnet - aim to give teachers a big help to use digital materials prepared and tested.

The European Schoolnet (EUN) is a network of 30 Ministries of Education in Europe and beyond. EUN was created 15 years ago to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers and researchers.

In this paper I also describe a good resource created by myself, for teaching Electricity in the secondary or primary school. The presented resource can also be used by teachers at colleges, even in the BSc education program. Usually in a BSc program students should learn some fundamentals of physics, but unfortunately majority of them do not have the basic knowledge in electricity, since they come from different schools. Therefore, I think, that the presented digital material can also be used for the reinforcement of BSc level students' knowledge.

The following Good Practice (called GP in the following) includes basic multimedia elements and online quizzes created by Web 2.0 technology. Multimedia elements related to the topic have been built together using a free online course management system (MOODLE). Some multimedia elements, like video recording, presenting hands-on experiments or quizzes, etc. have been created in different groups of students, who were divided in little groups in advance. During the test of the GP the well known project method has been used.

1. Used method: project method

The project method is an educational enterprise in which students solve a practical problem over a period of several days or weeks. The duration of the project is defined by the teacher, or by the project manager, who controls the whole project. The first appearance of this method can be dated back to about 1800, but its more frequent use occurred only in the 20th century. The main advantage of the method is that the

participating students can carry out activities which correspond to their interests. The student's activity can be controlled during the whole project, which also means that they can be better motivated.

A practicing teacher in the described project I also have used the project method as a qualitative method of pedagogy, and as a demonstration of and motivation for the scientific research activity. The method is complex enough to efficiently mobilize masses of students to meaningful learning and to help them acquire knowledge that they can use effectively. Beside the project method I also applied enthusiastically the cooperation learning - Dr. Spencer Kagan's method - to change the attitude of the students towards physics. None of these methods could be assessed, and worked out without the use of the ICT techniques.

2. SPICE, SCIENTIX collaborative project

In December 2009 a consortium consisting of the European Schoolnet (EUN, Belgium), Dum zahraničních služeb MSMT (DZS, Czech Republic) and Direção Geral de Inovação e Desenvolvimento (DGIDC, Portugal) launched SPICE, a 2-year project funded by the European Commission's Lifelong Learning Programme (DG Education and Culture). The aim was establishing a Science Pedagogy Innovation Centre for Europe. The experts came from all member countries of the project, public schools (usually a person / country) who are current.

The created new initiatives have been implemented in 16 European countries, by teachers and experts.

The aims of the project were the following:

- to create interesting, easy-transferable good practices: GP
- to create teaching materials in mathematics and sciences and technology,
- to predetermine criteria selected from other teaching materials,
- to test the created GP by the participants of the countries,
- to use Moodle (<http://moodle.org/>) free online course management system for developing of the material,
- to create a curriculum that is taught in other European countries.

Conclusion

This study highlighted the barriers that militated against successful integration of ICT in Physics education. However, teachers need system-wide support to implement ICT. This means that the schools, district, local community and state share with teachers a commitment to using ICT to support teaching and learning. In addition to that, the government should supply sufficient ICT teaching facilities to schools; facilities such as computers, computer laboratories, projectors, educational software and ensure all schools are internet compliance. The facilities should be well monitored to make sure they are not vandalized, misused or stole; this could be done by charging the school management with this responsibility. Furthermore, professional development should be emphasized. Successful ICT integration hinge on well- trained and motivated teachers. Therefore, ICT workshops, conferences and seminars should be conducted time to time and make its compulsory for Physics teachers to attend. The workshops should guide teachers on how to employ new media devices for teaching and learning; to create effective digital presentations using common tools for preparing slide shows, videos and podcasts; to develop confidence and ability to communicate using digital tools; to choose the most appropriate research tools and databases, and applies the most effective searching techniques; to produce useful and safe online resources in the classroom; and to capture and edit images, audios and videos. With the help of the innovation – the attitude improving projects – we have come closer to the goal of having students who are autonomous, have a creative way of thinking and by integrating their experimental, theoretical, mathematical and IT skills they are able to have proficiency of knowledge that is universal and useful.

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