© University Press 2022
ISSN 2719-6550
ISSN 2719-7417 online

"Journal of Education, Technology and Computer Science"
No. 3(33)/2022
www.eti.ur.edu.pl

Received: 2.11.2022
Accepted for printing: 1.12.2022
Published: 22.12.2022

DOI: 10.15584/jetacomps.2022.3.17

BEATA SEMKÓW-NĘDZA

Practical Application of ICT During Physics Lessons

ORCID: 0000-0002-1231-0685, M.Sc., eng., University of Rzeszow, Institute of Pedagogical, Poland

Abstract

The constant changes taking place in society, digitization, the use of ever newer technological solutions, should also generate changes in the way knowledge is transmitted to students. The article presents examples of information and communication technology (ICT) tools used in physics lessons. The ways and advantages of using the modern ICT tools discussed are also presented. The use of modern ICT tools should facilitate the understanding of physical phenomena and concepts.

Keywords: ICT tools, physics, key competencies, smartphone

Introduction

The last decades of the 20th century brought intensive development of modern technologies. Today's students belong to the first generation growing up surrounded by modern technology and communication tools. They spend a significant part of their lives with a smartphone or other mobile device. Today's young people use the latest tools of the digital era, which have already become an integral part of their lives. There has been a radical change in students' behavior, perception of the surrounding world and students' perception of stimuli (Prensky, 2001, p. 1). A number of terms are known in the literature about modern students. Digital Natives (Prensky, 2001, p. 1), the Homo Zappiens generation (the generation of multimedia children), the Millennial Kid (the child of the turn of the millennium) (Tanaś, 2004, p. 7), Homo Interneticus (the modern man connected to the Internet) (Walat, 2016, p. 236).

The article will present selected ICT tools, examples of application and the benefits of using a specific tool during a physics lesson. Simulations of experiments, physical measurements using applications available for smartphones

and other applications that introduce an element of surprise during the lesson, interactive games to test the knowledge acquired by students will be discussed in detail.

The subject matter of the study. Modern technologies in education

The key competencies established by the European Parliament and the Council of the European Union have become a response to the continuous development of modern technologies and the constant changes in society. Key competencies are called a combination of knowledge, skills and attitudes appropriate to the situation, which are necessary for self-realization and personal development (Council Recommendation of 22 May 2018 on key competences for lifelong learning. Official Journal of the European Union C189/7, 2018). Eight key competencies were specified, among which were digital competencies.

Analyzing the information, from the recommendations of the Parliament of the European and the Council, it should be noted that having digital competencies is essential for living in a modern society. Key competencies are necessary when communicating, seeking creative and innovative solutions. It is also important to be aware of the opportunities offered by modern digital tools, the limitations, consequences and risks associated with their use (Council Recommendation of 22 May 2018 on key competences for lifelong learning. Official Journal of the European Union C189/9, 2018).

Key competencies, including digital competencies, should be formed during the teaching-learning process, in the course of each lesson. The problem of using modern tools of technology and communication in the daily work of the teacher, was also included in *the Integrated Skills Strategy 2030* (Integrated Skills Strategy 2030, p. 31).

Research methodologies and tools

The research was conducted using the analysis of commonly available solutions regarding the possibility of using ICT in teaching physics in the school environment.The priority task of a modern school is to develop key competencies among students, which in the future, will allow them to function independently in a digital society. This raises the question of how to integrate modern ICT tools into the educational process. ICT tools should become an integral part of every lesson.

Analysis of research results. ICT tools in teaching physics

The necessity of using modern technology and communication tools is accentuated in many scientific studies. Similarly, the advantages of using these tools during lessons. The article will present selected applications of ICT tools, with a particular focus on physics lessons and the benefits of incorporating

a particular tool into the teaching-learning process. Physics is classified as a natural science. The task of physics is to learn about the laws governing nature, physical phenomena, properties and transformations of matter and energy. When considering the use of ICT tools during physics lessons, it is worth starting with one of its most essential elements – experience, since observation and experience are among the basic research methods in physics.

Physics lessons should educate a scientific view of the surrounding world. An experiment, an experiment conducted during a lesson, is an indispensable part of it. In the curriculum basis for teaching physics, there are numerous references to performing experiments during lessons, such as *planning and carrying out observations or experiments and making inferences based on their results* (Regulation of the Minister of National Education of February 14, 2017 on the curriculum basis for kindergarten education and the curriculum basis for general education for elementary school, including for students with moderate or severe intellectual disabilities, general education for an industry first-grade school, general education for a special school for work, and general education for a post-secondary school, Journal of Laws 2017 item 356, p. 153).

The above quote emphasizes the necessity of conducting experiments in the course of a physics lesson. Unfortunately, the reality of the classroom introduces many constraints on how to conduct an experiment during a lesson. The school's physics lab may not be equipped with the right equipment for the number of students in the class. Some experiments pose a danger during the lesson. It is also worth noting the need to explain a given experiment, which is not an easy task for students, especially at the molecular level. In the described situations, simulations of experiments, animations, virtual laboratories, e-experiments become very helpful. The teacher has a wide choice of websites, where modern multimedia tools are available that will accurately reproduce the experience in question. Appropriate to the topic of the lesson and thoughtfully simulations of experiments help students understand physics.

American physics didacticians N.D. Finkelstein, K.K. Perkins, W. Adams, P. Kohl and N. Podolefsky in their research showed that a group of students in which the teaching process was supported by simulations achieved better results and understood physics to a greater extent, compared to students taught by traditional methods (Sokolowski, 2009, p. 43). The author of the aforementioned article referred specifically to *PhET* simulations (Internet 5).

PhET simulations are a free tool available to both student and teacher. The authors provide dozens of interactive simulations in physics and other science subjects. For example, using a simulation on diffusion, a teacher can explain the phenomenon to students, illustrating the process of mixing of molecules, which is invisible to the human eye. The user can choose the appropriate parameters of the experiment, setting, for example, temperature, mass and other physical quantities depending on the simulation (Figure 1).

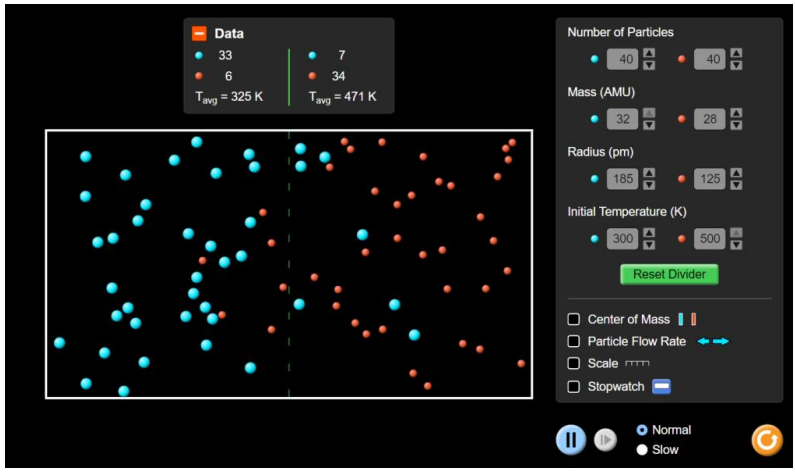

Figure 1. *PhET* simulation showing the diffusion process

Other physical simulations are also available. Worth mentioning are the interactive tools provided by the Czech teacher Vascak (Internet 14). The site offers simulations and animations of physical experiments on many school topics, such as the principle of the hydraulic press (Figure 2).

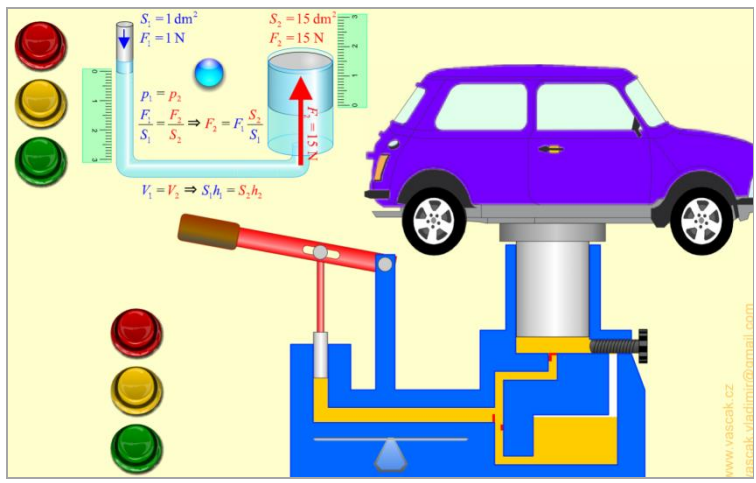

Figure 2. Simulation showing the principle of the hydraulic press

At this point it is also necessary to introduce the three-dimensional *e-Experiments in Physics*, made available free of charge on the website of the Gdansk University of Technology (Internet 1). Using the *e-experiments*, for example, one can perform an interactive experiment to investigate what the period of oscillation of a mathematical pendulum depends on (Figure 3).

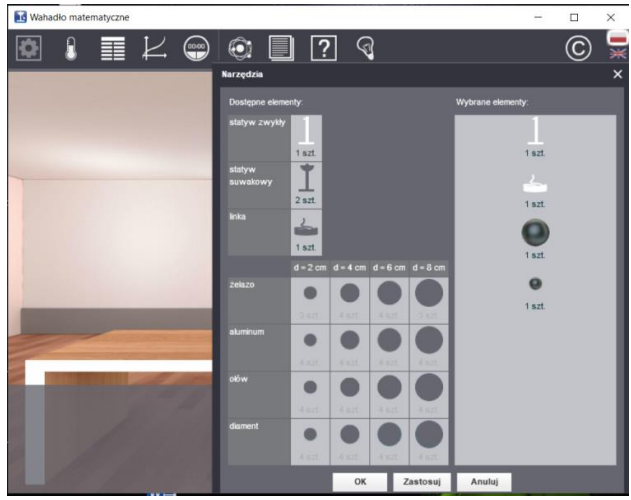

Figure 3. Simulation showing the creation of an experimental set-up to study the dependence of the period of oscillation of a mathematical pendulum on selected factors

A physics teacher can also use a number of other websites where simulations and animations of experiments are available. Some examples include: *physics classroom* (Internet 13), *Apps on Physics* (Internet 15), *Virtual Physics Laboratory* (Internet 2).

Measurements also play a very important role in physics. Referring again to the core curriculum for teaching physics: *a student distinguishes between the following concepts: observation, measurement, experiment; carries out selected observations, measurements and experiments using their descriptions* (Regulation of the Minister of National Education of February 14, 2017 on the core curriculum for pre-school education and the core curriculum for general education for elementary school, including for students with moderate or severe intellectual disabilities, general education for an industry school of the first degree, general education for a special school for special needs, and general education for a post-secondary school, Journal of Laws 2017 item 356, p. 153). In the implementation of the presented requirements from the core curriculum, students' smartphones are becoming helpful.

Modern smartphones are equipped with numerous sensors that, with the use of appropriate applications, allow the user to perform a specific measurement. An application that is very popular among physics teachers is *phyphox* (Internet 6). Using the application, one can, for example, record raw data from a magnetometer, determine acceleration and position. The app's authors have also offered ready-made guidelines for conducting an experiment, often with instructions in the form of a video. Among the proposed experiments are a free fall test, elevator speed test, among others.

Another application available for smartphones is the *Physics Toolbox Sensor Suite*. This app provides similar measurements to the *phyphox* app described earlier.

When discussing the apps available for smartphones, it is worth noting the apps that allow generating sounds of a set frequency, as well as creating oscillograms of sounds of different heights and volumes. Referring again to the provision from the core curriculum: *the student experimentally observes oscillograms of sounds using various techniques* (Regulation of the Minister of National Education of February 14, 2017 on the core curriculum for pre-school education and the core curriculum for general education for elementary school, including for students with moderate or severe intellectual disabilities, general education for an industrial school of the first degree, general education for a special school for special education and general education for a post-secondary school, Journal of Laws. 2017 item 356, p. 158), applications will be presented that enable the implementation of this requirement using ICT tools.

These functions are available in both *phyphox* and *Physics Toolbox Sensor Suite* applications. There are also applications designed exclusively for the aforementioned measurements. Among them are *Frequency Generator*, *Sound Analysis Oscilloscope*, for example. Figure 4 shows sample oscillograms of sounds, created successively in the *Sound Analysis Oscilloscope application* (Figure 4a) and *Physics Toolbox Sensor Suite* (Figure 4b).

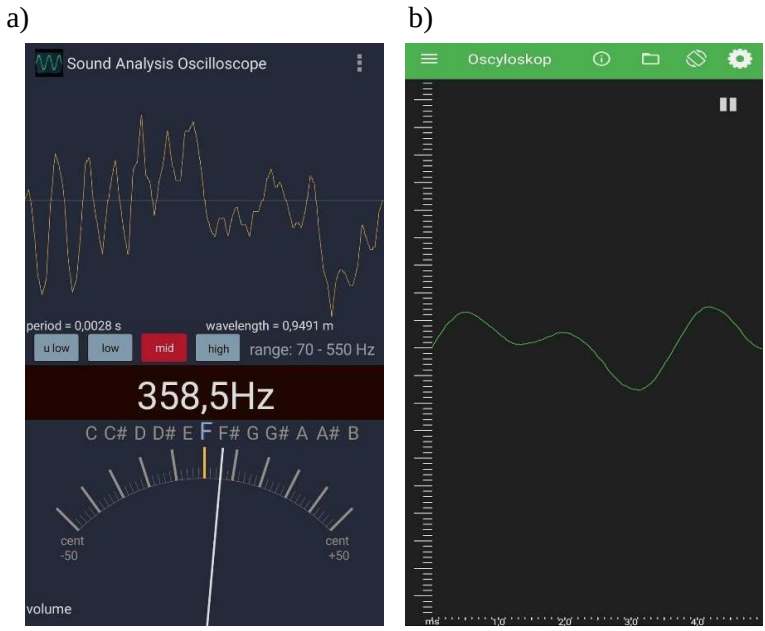

Figure 4. Smartphone screenshot showing oscillograms of sounds, sequentially in the a) *Sound Analysis Oscilloscope app*, b) *Physics Toolbox Sensor Suite app*

In order to increase students' interest during the lesson, to introduce an element of surprise, it is also worth introducing online tests and other ICT tools for getting immediate feedback from students. Mind maps (*mind mapping*) are becoming increasingly popular. The purpose of creating a mind map is to increase the effectiveness of remembering and reproducing messages, through the process of organizing knowledge and linking information to previously acquired knowledge (Marian, 2008, p. 100). Creating a mind map together with students will work well during a lesson summarizing a section. Mind maps can be created using traditional techniques and by using modern tools available online for this purpose, such as *Miro* (Internet 4), *Mindomo* (Internet 12) applications. Also of great interest among students are online tests that introduce elements of *game-based learning* (game-based education) during lessons. One of the most popular platforms for creating online tests is *kahoot* (Internet 3).

Using the *kahoot* platform, an interactive test can be created for students. A great advantage for both the student and the teacher is the immediate feedback on the correct and incorrect answers given by the students. Other exemplary educational platforms for creating online tests are *wordwall* (Internet 9), *quizlet* (Internet 8). The advantage of the wordwall platform is the creation of quizzes, using various templates, such as wheel of fortune, find a pair, true or false, missing word. *Quizlet* allows the creation of tools such as fiches, picture cards, supporting the learning of concepts and definitions, which in the case of teaching physics is also of great importance.

Another tool for conducting a quick question in the classroom is *Plickers* (Internet 7). The unquestionable advantage of this tool is the need for only one smartphone – the teacher, unlike previous apps. Each student is given a unique pre-printed code, which he or she must point in the direction of the teacher. The student indicates one of the answers (A, B, C, D) by setting the code with the corresponding edge up. The teacher immediately receives the results in the form of a bar chart and the answer given by each student.

Conclusions and generalizations

Summarizing the previous considerations, it should be said that modern ICT tools enable interesting solutions during lessons. ICT tools modify the teaching-learning process. By integrating ICT tools into the teaching process, the teacher can increase the effectiveness of teaching and directly influence the process of students' understanding of physics. ICT tools can be used in various combinations and teacher-student, teaching-student activity interactions. Focusing on physics lessons, it is important to appreciate the role of simulations, animations and other interactive tools, the use of which will allow students to present experiments that previously could only be carried out in well-equipped laboratories. In the process of teaching-learning physics, the smartphone has also become a use-

ful tool. Thanks to the sensors hidden in the smartphone, it can be successfully turned into an accurate measuring device. It is also worth remembering to use the smartphone as a tool for communication, as well as a tool for solving online tests and building interaction during lessons.

References

Council Recommendation of 22.05.2018 on key competences for lifelong learning. Retrieved from: https://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:32018H0604(01)&from=EN (28.08.2022).

Integrated Skills Strategy 2030 (general part). Retrieved from: https://efs.mein.gov.pl/zintegrowana-strategia-umiejetneosci-2030-czesc-ogolna/ (20.08.2022).

Internet 1: http://e-doswiadczenia.mif.pg.gda.pl/glowna-pl (16.08.2022).

Internet 2: http://fizyka.if.pw.edu.pl/~wlf/ (16.08.2022).

Internet 3: https://kahoot.com/schools-u/ (20.08.2022)

Internet 4: https://miro.com/mind-map/ (20.08.2022).

Internet 5: https://phet.colorado.edu/ (20.08.2022).

Internet 6: https://phyphox.org/ (16.08.2022).

Internet 7: https://www.plickers.com/ (20.08.2022)

Internet 8: https://quizlet.com/pl (20.08.2022)

Internet 11: https://wordwall.net/pl (20.08.2022)

Internet 12: https://www.mindomo.com/mind-maps-for-education (20.08.2022).

Internet 13: https://www.physicsclassroom.com/Physics-Interactives (16.08.2022).

Internet 14: https://www.vascak.cz/physicsanimations.php?l=pl (20.08.2022).

Internet 15: https://www.walter-fendt.de/phys.htm (16.08.2022).

Marian, M. (2008). Mnemonics and "mind maps" as tools to support the learning process. *WSOWL Scientific Notebooks*, *4*(150), 100.

Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon*, *9*(5), 1. doi: https://doi.org/10.1108/10748120110424816.

Regulation of the Minister of National Education of 14.02.2017 on the core curriculum for pre-school education and the core curriculum for general education for elementary school, including for students with moderate or severe intellectual disabilities, general education for an industrial school of the first degree, general education for a special school for special education and general education for a post-secondary school. Journal of Laws. 2017 item 356, p. 153. Retrieved from: http://prawo.sejm.gov.pl/ (20.08.2022).

Sokolowski, A. (2009). Physical simulations as an effective teaching aid. *Photon*, *107*, 43–47.

Tanaś, M. (ed.) (2004). *Pedagogy @ computer means and media*. Warsaw, Cracow: Impuls.

Walat, W. (2016). Homo interneticus – a challenge for modern education. Education – Technology – Informatics, *4*(18), 235–242.