Scientific Communication Skills in Education with ICT Tools

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Abstract

Information and communications technology (ICT) has been used by academic researchers since the 1980s, but the technology has revolutionized our world and daily lives, and is continuously changing. Therefore new tools always arise, which have to be introduced in education [1].
The aim of this work is to share some good adaptable examples of ICT in action, *tools, resources and methods used in education indifferent of the subject which will be taught [2].*
During the pandemic period many different methods have been used: teleconferencing, MS TEAMS, Google Meet or ZOOM (delivering lectures and talking about simulated events explaining a physical phenomenon) for enhancing students' motivation.
Each example presented has already been used, or will be used shortly at high schools and college BSc level.

Keywords: *ICT, BYOD, video experiments, simulation, online assessments, learning apps*

1. Introduction

Differences between interpersonal-communication technologies and mass-communication technologies have been identified theoretically by the philosopher Piyush Mathur.[3] His critical explorations focused on the re-evaluation of technology and communication. According to his study, the use of communication and its development play an important role, and has to be introduced in education in the 21st century. In particular, scientific communication has also become an important issue in society.
As we all know, communication is a very basic and fundamental process for human beings, it is the act of sending and receiving information or ideas via speech, visuals, writing or any other method.
The main key question is: how should ICT be used for education, for communication, etc.? Should we let students to bring their own devices, use their equipment for experiments, or use for creating scientific webpages, to control remote experiments, to study of the simulations, etc. [4]?
The following hypothesis formulated, goals, of use of ICT in education are very similar to the presented ones in the lecture made at e-Skills EU Conference, in March 2010:

- to improve the memory of students (Inquiry-based learning)
- to improve their understanding
- to create interactive classes (use of simulation)
- to make lessons more enjoyable
- to flip the classroom
- to improve concentration of the students,
- to rise up the students' interests,
- to evaluate students' performance using different methods of ICT.

In the beginning of the lockdown period of COVID-19 many new barriers raised up, which had to be defeated. It was a real challenge for both students and educators. We had to act immediately, we had no time for careful and long preparation and study, we had to explore and use the new pedagogical modalities which did not require physical presence in the classroom.
All of us we knew that the online teaching and learning represented many challenges and had weaknesses, but online teaching was the only solution to maintain the education and reduce the number of the infections.
Information and Communication Technology and Mobile Technologies played a very important role in the education during this period. However, to have only the tools was not enough.
As teachers, we had to concentrate more on the preparation of the online lectures and the tasks assigned to students. We had to keep our students' interest still alive and to attract them to online courses.
Therefore, depending on the material taught we had to assign different colourful interactive activities which required more and more communication from students. In this paper some selected and adaptable concrete examples of "ICT in action" will be presented, which were used in Physics teaching.

The implementation of the activities mentioned earlier was only successful if we continued to focus on our previous goals, such as increasing students' motivation, learning and innovation skills, digital literacy skills, and preparing them for their careers and lives [4].

2. Target, participants

The following implementations have been done in the past year with my students from high school and college BSc level, who were enrolled to compulsory Physics classes. Students enrolled to my course took part either in full training education (FT) or Distance training education (DT).

3. Teaching methods used

Our choice of teaching method depends on our educational philosophy, classroom demographic, subject area(s), available laboratories or resources, subject curricula, or school mission statement.
Different teaching methods can be used in traditional classes, but some of them cannot be longer used while students and teachers are sitting in front of a computer.
In 21st century the new teaching methodologies are changing the world's educational environment and providing better academic performance among students. Currently, the following student-centred learning methods:

- Flipped Classroom
- Project-Based Learning
- Cooperative Learning
- Gamification
- Problem-Based Learning
- Design Thinking
- Thinking-Based Learning
- Competency-Based Learning

and

- Lecture method (teacher-centred method) are the most commonly used [5].

During the lockdown period of COVID-19 in my online Physics classes, depending of the material, I used both methods: teacher-centred and student-centred learning.

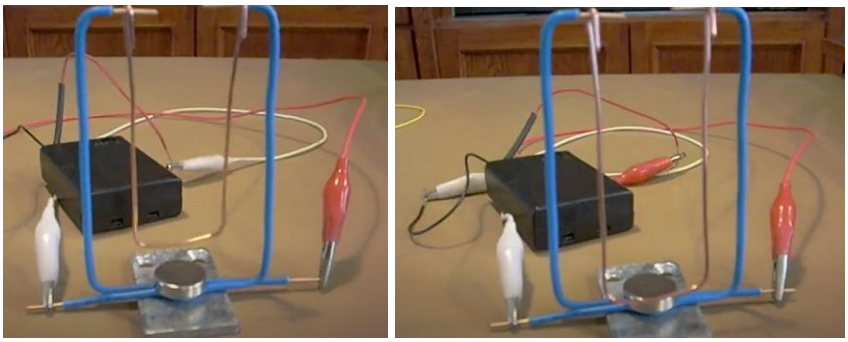
3. Examples of ICT in action

The use of ICT became a common requirement in education, and it has been introduced in the educational process in many schools and universities. Based on my previous experiences and many studies related to attitudes of students to physics in high schools and in universities it has become clear that physics classes should be made more colourful, attractive and interactive. This goal during the pandemic period was an extra challenge. In order to improve students' researching, questioning, critical thinking, problem solving, decision making, computational competencies, communication skills, I had focused more on different types of activities (home-made, hands-on experiments, ICT based activities: educational games, study of simulated phenomena, video-experiments, discussion of phenomena). The aim of this work is to show some selected, good examples of the resources from the online course prepared to teach fundamentals of electricity.

3.1. Use of E-learning course

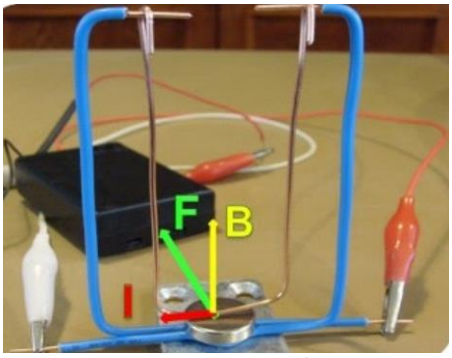
During the COVID-19 period I have created a completely new online E-learning material for my students enrolled to Electricity courses. The new material is completely free, responsive, can be used online on any devices: https://sites.google.com/view/2019villamossagtan/home.
This material is in Hungarian, including many own video experiments and English video records, simulations, player tests and ICT tasks based on gamification. This course consists of the following main chapters (Electrostatics, Electricity, Magnetism, Alternating current). Each chapter includes self-assessment, interactive test questions, and pre-designed, solved tasks.
During my half year course (45 hours) I used my prepared material with assigned activities embedded with different methods.
In the introduction to the Physics laws I used the lecture method, one of the traditional ways of teaching Physics. Here the differences from the traditional method consisted in the use of videoconferencing and online platform. This method is teacher centred; the teacher has the main role, but this had to be adjusted to lockdown possibilities. For raising up the student's concentration I asked them questions many times during my talk, where they needed to act immediately, verbally. I used an interactive presentation platform making it easy to listen and be heard https://www.mentimeter.com/

(live polls, quizzes, word clouds). Since they had to give feedback, make some explications, they have been involved in the discussion, which improved their verbal communication skill continuously.
For example: presenting my own recorded video experiment:
https://www.youtube.com/watch?v=sIg_xuLpJuU and https://www.youtube.com/watch?v=Aj6V8snrFvA



Self-made experimental tool

I asked them to discuss and predict the direction of the movement of the swinging wire, if we know the direction of the magnetic field and the direction of the current flowing?



Answer to question

3.2. Use of game-based learning platform

All students have access to the new online E-learning material published in advance, and they can review and learn the content taught after each lectures.
After the main parts and some chapters taught, I have tried to ask the students for the syllabus in a playful way without grading. The following two free game-based learning platform were used: Kahoot (https://kahoot.com/) and Socrative (https://www.socrative.com/).
Using the quiz questions created for different online platforms I evaluated the students using two methods. Sometimes I asked the students to give anonymous answers, other times I asked them to give their names. I think that the students took the test more seriously when they had to include their names. My idea was to make this course fun and attractive, and focusing students‘ learning always to scientific definitions, terms, and content.

3.3. Use of Remote Experiment

Before starting the experiment students had to be waked up with the following questions:

- Can moving objects produce electric currents?
- How to determine a relationship between electricity and magnetism?
- If you insert a magnet into a coil of wire what will you observe?
- Will you observe electromagnetic induction or no?

For starting of the discussion they must look at first to the following simulation:
https://www.vascak.cz/data/android/physicsatschool/template.php?s=mag_indukce_accel&l=en
and https://www.youtube.com/watch?v=2_M83gNOOEg animation.
Applying inquiry-based learning, students made observations, and found out the answers, possible explanations to introductory questions.
After this short scientific discussion the whole group started to use the following free, online remote experiment individually: Electromagnetic induction - Remote controlled laboratory (cuni.cz).

A remote experiment is a real experiment with real laboratory instruments and equipment that can be controlled by any computers through the internet [7].
First students get familiar with the equipment, and experimental set-up. They already get the objective of the experiment which has been formulated in advance:

- To study the phenomenon of electromagnetic induction,
- To check the validity of Faraday's law, making a connection between voltage and angular rotation speed of the coil,
- To check the validity of Faraday's law, making a connection between electric motor voltage and angular frequencies.

Before starting the real work some predictions and possible expectations had to be formulated.
With the possibility of the remote experiment students learned to do experiment with a rotating coil with homogeneous magnetic field. They run the experiment from their home.
They could change the angular velocity of the coil by changing the voltage of the motor that drives the rotating coil. They had measure the induced voltage in function of the voltage applied on the driving motor (which was proportional to the rotation frequency of the coil). This experimental setup gave them the possibility to change the voltage from 2 V up to 10 V, and save the measured data. They measured 10 points of the angular velocity of the coil and export the measured data.
With the exported data students were able to make the graphical representation of induced voltage chart.
After the experimental work students had to start the real discussion about their activities and results. First they formulated open and close questions to each other, and answering, reflecting and clarifying their answers they became closer and closer to real definition of the topic and understood better the Electromagnetic induction. Finally they summarized the law formulated previously in the objectives.
Inclusion of the remote experiment has many advantages. Students understand and learn the phenomenon of electromagnetic induction and also learn and memorize the relation between induced voltage and the changing speed of magnetic flux.
Theory: Electromagnetic or magnetic induction is the production of an electromotive force across an electrical conductor in a changing magnetic field.
The use of the remote experiment in general has also many impacts:

- experiments can be carried out from anywhere in the world;
- no time restriction since experiments are available 24 hours a day, 7 days a week;
- no limited laboratory capacity for numerous students
- safe and secure operation of equipment without danger of user's injury;
- students enrolled to Distance training education, can also get involved in the activity,
- no personal contact during a pandemic period.

During the whole online activity I have followed and instruct my students, helped them when they needed, and enjoyed working with them, sawing their continually improvement [6].

3.4. Use of Simulation

During my experience under the pandemic period, I became convinced that it is impossible to adequately teach some parts of physics without the use of experiments presented with simulation programs.
The benefits of computer simulation programs must not be misinterpreted to mean that a computer can be the sole provider of instruction for students of physics and natural sciences! Nothing can replace the “real” experiment and the personality of a good physics teacher.
However, interactive, multimedia-based computer simulation programs offer a unique opportunity for students to make experiments without personal contact. Well-written simulation programs help students to understand better the phenomena or the laws of physics. Especially during the COVID-19 outbreak period the use of the simulations in Physics courses was essential.
Students got a pre-prepared worksheet with the concrete objectives, tasks and questions. They started to use the given link: Alternator and dynamo (vascak.cz).
Analysing the task alone, they had to try to answer the given questions, and after 15 minutes they had to start a discussion about the topic. During the discussion all of the students have been involved.
During the scientific discussion students had to answer the following questions (only a few of them are selected for this paper).

- If they turned on the magnetic flux what was happening when the coil started rotating?
- Predict and answer: when do we get induced voltage? What are the requirements?
- Understand: why can we see that the pointer of the galvanometer moves in both directions?

- Is there any possibility to adjust the setup, to move the pointer only in one direction, why we can do that? Detailed discussion required.
- How is the flux changing, when the speed of the coil is changed?

The understanding of the curriculum was very successful due to the application of the simulation program, as it further supported the measurement performed with the previous experiment and law.

4. Conclusion

From personal interviews and from the anonymous questionnaires filled out by the students I can conclude that they liked the innovative teaching methods, they also liked to stay in front of the computer, and were not too much frustrated because they had to learn online during the whole year.
Especially students enrolled to distance training education were very happy and thankful, because they were able to access and watch also those video recordings, which were made with full training students during the classes, which we usually do not do during the normal classes.
Finally, students felt that many colourful activity was very useful, and it motivated them more to carry out their tasks, to share their screen, and make some puzzles, to do calculations and to answer the online questions.
They also very much liked to do remote experiments, and to discuss the physical law or phenomena, to use of the simulations followed by discussions.
Finally, I can conclude that this work had a lot of positive effects. Student feedback supported the fulfilment of the formulated hypotheses. The use of ICT clearly motivated the students, and also the several oral tasks built into the course developed their scientific communication skills.
For me it became clear that if we use only the same old strategies, methods and techniques we will never change the Z generation's attitude related to science subjects.
Student's attitude can be changed only with introducing more and more innovation in our courses, with colourful activities, where we give them the possibility to express themselves and use their scientific vocabulary, their scientific communication skills.

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