Experiences in teaching science from children to adults

Dr. Beata Jarosievitz Ph[1], Hasznosi Tamásné[2]

Dennis Gabor College, Institute of Basic and Technical Sciences (Budapest, Hungary)[1], Sashalmi Tanoda Általános Iskola [2](Budapest, Hungary)

Abstract

Education plays a very important role in the development of a society. The interest in specific forms of learning strategies - such as formal, non-formal and informal - began with the 1960s "world educational crisis" [1].
Authors of several contemporary publications agree that different learners learn in different ways. Some of the learners learn from textbooks, webpages, online quizzes, free YouTube video experiments and from simulations, which they can manipulate themselves; or they go to museums with their families (chose non formal learning), or join one of the Researchers' Night's activities offered for students [2], or join and follow the class activities and lectures delivered by their teachers (choose formal learning).
It seems that „it is difficult to make a clear distinction between formal and informal learning as there is often overlap between the two."[3].
Based on our expertise gained in more than 20 years of professional carrier as teachers and pedagogical advisors, we will present some of the good examples of teaching a simple Physics law in this work.
Newton's laws will be discussed using different teaching methods (e.g.: experiments with a performance, etc.[4]). Schoolchildren and college students and even continuing education adults (between 10-40y) were involved in the reported activities.
The main aim of the activities performed was to increase the popularity of natural and technical sciences, to motivate children and students and to build their key competencies in all learning areas using different teaching methods especially during the lockdown period of COVID-19.

Keywords: *hands-on experiments, simulation, YouTube videos, ICT tools, interactive activities*

1. Introduction

During the lockdown period we realised again that traditional physics classes do not attract students, the popularity of „Physics" classes must be increased. Most students have at least one digital device (tablet, smartphone), but usually they do not use them for their studies (e.g. watching simulations related to the subject).
Analysing the previously mentioned facts we formulated the following hypotheses:

- hands-on activities engage students to form useful scientific concepts,
- exercises with real-life scenarios bring students closer to Science,
- colourful digital classes rise up the lectures' attendances,
- game-based learning motivates students to learn more.

We expect that after the non-formal and formal activities presented below we will see major changes on student's attitude to study, and our students will be much more interested and enthusiastic to learn and understand Physics laws.
We are expecting the followings:

- to make physics lessons more fun,
- to increase the connection between physics and daily life,
- to focus more in students' learning based on experimental work.

2. Target, participants

The following project was a collaboration between a group of volunteer students from a primary school (in this paper called: "presenters") and students from high school and college BSc level enrolled to compulsory Physics classes (in this paper called: "listeners").
Students enrolled in my course ("listeners"), in the normal classes, are partly only passive listener of the Physics courses, they cannot really enjoy, or be involved in any real experiments, because we do not have a Physics laboratory. Even with an existing laboratory during the pandemic period all of the

students had to learn online, from home, therefore the video recorded experiments and simulations had help them a lot to do the study from home.
Students who are presenting the recorded experiments (“presenters”) belong to a primary school. They are member of a group of volunteer’s students, who already participated in a country-wide non-formal learning activity. Three years ago this group presented a Physics show for the Researchers’ Night event. Presenters made their experiments in front of a big audience about 150 people. This event was also broadcasted via television, and online video. Presenters’ exceptional tutor and physics teacher, the second author of this paper, introduced this “volunteer group” to experimental work, and also she explained them the basic physical phenomena.

3. Teaching methods used

In this paper 3 different types of method will be presented below.

3.1 Cooperation method

Both groups: listeners and presenters were involved in the cooperation method. Students of primary school were divided in small groups of 2-3 members. All groups transformed the classroom into an attractive environment.
Using this method we had two main aims: based on the video recorded experiments we tried to help the listeners - online learning students - to understand Newton’s first law better, and also we tried to help the presenters in understanding Newton’s laws with their own experiments.
Some presenters were involved in the hands-on experiments, some have prepared some fun quiz questions, and some others were working out some problem-solving exercises.
Before starting the experimental activity the students had to make some predictions, collect the requested materials and set-up the experiment. Listeners enrolled to my Physics course during the lockdown period were online, therefore they watched only the recorded video experiments, and started to discuss online about the viewed phenomena. They had to focus on better understanding of Newton’s first law - Law of Inertia.

1st experiment

This experiment (Fig.1) required a glass, paper, coin

1. Figure: Law of Inertia using coin and glass

In the first step, presenters had to take out the paper slowly and in the second step they take out the paper quickly, with higher speed (higher acceleration). See the recorded video: video1, video2. After the experiments students started a conversation for developing and improving their critical-thinking and argumentation skills. Students concluded, that the objects will remain at rest or in a uniform motion along a straight line, unless acted upon by an external unbalanced force.

2nd experiment

This experiment (Fig.2), required an apple, a skate board, a teddy bear and a wall.
Students watched the recorded video: video3, video4


2. Figure: Law of Inertia with apple and teddy bear experiment

Many good questions raised up after the observation done

- What will happen when the skateboard with the apple is pushed by the student, and will hit the „wall"?
- Have you noticed, that the apple will continue to move forward when the skateboard changed his speed and/or direction?
- Why the teddy bear will continue to move forward when the skateboard changed his speed and/or direction?

Analysing the viewed experiments students concluded that some phenomena presented here are very similar what is going on in our everyday life (e.g.: when we travel by bus, and the driver suddenly brakes, we fall forward in our initial direction).

We focused on the students' expectations. Students likes their skateboard, and their roller skates, therefore they did the next experiment with roller skate. Of course, in Newton's age roller skates did not exist.

3rd experiment

This experiment (Fig.3), required a dish of water and one student with roll skate and 2 others.

We expected from the students to predict and talk about the next experiment watched: video5.

Explain: why the water from the dish will still continue to move forward, even if you are suddenly stopped.


3. Figure: Law of Inertia with a dish of water and students

With amazing experiments students understood very well the Law of Inertia.

3.2 Simulation

During the pandemic period we became convinced that it is impossible to adequately teach some parts of physics without the use of experiments presented with simulation programs. Especially during the COVID-19 outbreak period the use of the simulations in Physics courses were essential. Students got a pre-prepared worksheet with the concrete objectives, tasks and questions. They started to use the given link: (vascak.cz). Analysing the task alone, they had to answer to 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, formed their opinion of the viewed simulated experiment. In this context students had to study with simulation: Law of Inertia.

3.3 Inquiry-based learning

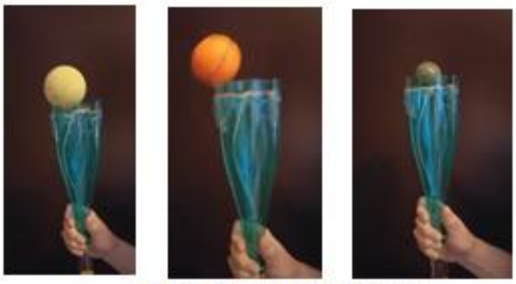
IBL is based on the constructivist conception of learning, and is also a form of active learning. Starts by posing questions, making observations, find out what information is already known, outlining possible explanations and creating predictions for future study of the problems or scenarios.

It is in contrast with traditional education, where generally the teachers use to present facts and the new knowledges about the subject.

All this expectations were embedded in the activity performed with the students. Before the starting of the activity, students who did the physics experiment were taught about Sir Isaac Newton. According to a popular story, during the Plague pandemic period, Newton was sitting in the garden on a sunny day and saw an apple fall from a tree. He was wondering why the apple, or any object falls down to the ground rather than sideways or up into the air. After several years of questioning he discovered the answer.

4th experiment

This experiment (Fig.4), required a PET bottle, bandaging rubber, a ruler, and a few balls with different weight. Please watch: video6 and video7. As you see, we applied equal force to all balls by pulling the rubber to the same length, we then observed that there is greater acceleration with the lighter ball due to less mass.



4. Figure: Newton's second law

With the presented experiment students concluded that the acceleration of an object is dependent upon two variables: the net force acting upon the object and the mass of the object.

In this project IBL was used for better understanding and study of Newton' second law.

5th experiment

This experiment (Fig.5), required a group of students and balloons in their hand.

With this experiment Newton's third law can be demonstrated very easily if we focus on the motion of the balloon and understand how the balloons and rocket engines work.

5. Figure: Newton's third law

4. Conclusion

Students enrolled in Physics course gave me very positive feedbacks about the video experiments recorded for better understanding of the Newton's laws.

Students involved in the experiments as presenters will never forget Newton's laws, they had a lot of fun, and enjoyed the small show they made from the presentation.

Based on the results and on personal interviews we can conclude that our formulated hypotheses have been confirmed: we made physics lessons more fun, and we increased the connection between physics and everyday life; our students involved in the activities became more motivated.

7. Acknowledgement

We are grateful and we were also honoured to work with the students, their attitude to work are valuable. Many thanks again also to school management, because they let us do the Physics experiments in the school gym, and let us involve the eighth grader students in this project.

References

[1] Coombs, P. H. (1968). The world educational crisis: A systems analysis. Paris/New York: UNESCO/Oxford University Press;

[2] B. Jarosievitz (2015): Unique activities organised for the Researchers' Night in Hungary Online: https://blog.scientix.eu/2015/03/unique-activities-organised-for-the-researchers-night-in-hungary/

[3] McGivney, V. (1999) Informal learning in the community: a trigger for change and development (Leicester: NIACE). Cited in 'Helen Colley, Phil Hodkinson & Janice Malcolm (2002) Non-formal learning: mapping the conceptual terrain. A Consultation Report, Leeds: University of Leeds Lifelong Learning Institute. Also available in the informal education archives: http://www.infed.org/archives/e-texts/colley_informal_learning.htm

[4] Hungary: drama in science: ALICE IN CHEMISTRYLAND (2011); https://www.scienceinschool.org/article/2010/sons-8/ ; https://www.youtube.com/watch?v=KI9yPV_kyxA

[5] P. Cleaves, „Bloom's Digital Taxonomy and Web 2 Tools," [Online]. Available: https://prezi.com/gxgypkp67mka/blooms-digital-taxonomy-and-web-2-tools/.

List of figures