Web 2.0 applications as the tools of motivation in secondary physics education

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Web 2.0 applications as the tools of motivation in secondary physics education

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Abstract. The aim of this study is to introduce some effective methods of integrating educational web 2.0 apps into Physics lessons, to share some experience and ideas how they can be used to support learning and make students more active in the learning process. This collection of apps focuses on the most popular activities of the students (using social media, playing online games etc.) A short insight will be given into the procedure how these modern techniques can foster the students' creativity, develop their collaboration skills, give opportunity to deal with differentiated learning problems and, last but not least, change the students' attitude towards learning Physics.

1. Introduction

Nowadays technology plays an extremely important role in the lives of the new generations of students. Every aspects of their daily life are managed by using modern devices and services. Moreover our society constantly changes thus students need to encount new challenges. They are required to acquire some more new skills such as digital, problem solving, critical thinking, collaboration skills and creativity. Therefore, new techniques and pedagogical models (such as flipped classroom, self-learning, project based learning, gamification, social media, free online learning tools etc.) are needed to prepare them for their future life. Comparing traditional pedagogical techniques to education today, it can be said, that nowadays the main challenge in teaching is to awake students' curiosity and desire to learn. Using web in their education is an effective way to do this.

Web was invented in 1989 by a British scientist Tim Berners-Lee, CERN (The European Organization for Nuclear Research) in order to share information among the scientists working there. Since then, a rapid development can be noticed in this area, three stages of internet growth (web1.0, web2.0, web3.0) can be realised. Thinking about web1.0 it means only sharing information, while the main feature of web2.0 is interaction. So it's more about communication and collaboration through different online platforms without any web design and publishing skills. Web3.0 is described as the future of web giving the users a much more interactive and personalised web experience. Plenty of web2.0 educational apps (social media, blogs, wikis, podcasts, webquests, e-learning resources, video sharing pages, maps, educational games, quizizzes etc.) are available and I am sure that everyone has already used some of them in classroom activities or in preparation for the classes.

While much has been written about how effectively web 2.0 applications can support the learning process in general, this paper is based on my experience of using web2.0 applications in Physics lessons in a secondary school. The aim of this collection is to give a brief insight into the learning and teaching process, to share experience how the apps can support the development of the capabilities mentioned above.The chosen apps cover different areas we used them for in order to illustrate how Physics lessons can be made more engaging and enjoyable without compromising the content richness and help students to gain confidence in using technology for learning.

2. Methodology

First I made a survey among my students, approximately 50 of them (aged 16-17 years) were asked to fill in a prequestionnaire about their using internet. Analysing their answers some conclusions can be made. (figure 1, figure 2) Most of them (68%) spend more than 4 hours online every day. Their most popular activities are using social network, watching films. Almost 25% of the students use internet for learning as well. They are those students who have already met some educational apps during their classroom activities, became familiar with them and use them regularly.

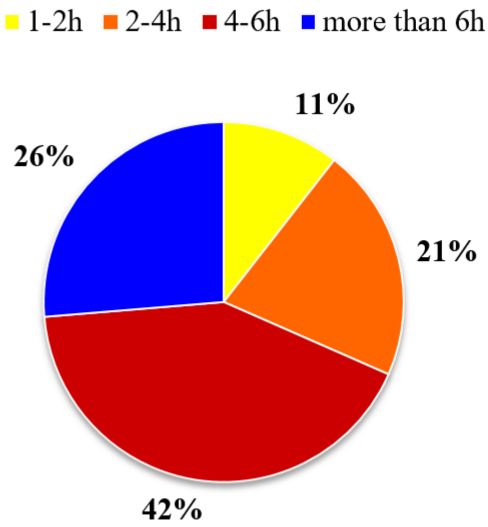

Figure 1. Spending time online/days Most of the students spend more than 4 hours online every day

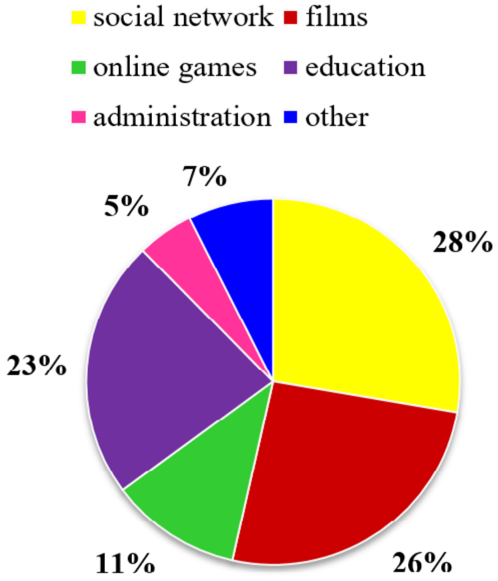

Figure 2. Areas of internet usage by the students

2.1. eTwinning

In the 21st century being able to collaborate and work well in teams, to share ideas and knowledge with others and also to learn from others are some of the most important aspects of learning process. Furthermore, it does not take too much effort to motivate students to get them engaged with social media in the classroom as they are always connected to their social network. So it can be said that eTwinning is a good way to combine these aspects.

eTwinning is an international social network for students and their teachers to collaborate across Europe. It provides a secure platform for the implementations of various projects and opens up new dimensions to teaching and learning process. It gives cross-curricular environment through intredisciplinary, cross-subject teaching. Learners are much more interactive in this process than in traditional one and they are also engaged in practical, inquiry based tasks. eTwinning can be a successful channel for developing students' competencies mentioned above as several of them can be addressed simultaneously by project based learning method.

To set up an international project the main steps which have to be taken into account are the followings:

First, you have to make a plan with your partner/partners, then choose the students involved in the project, determine the activities, their deadlines and the language you are going to work in. After then, you have to submit your plan on to the platform and wait until the project will be approved by the National Support Services (they give the permission to use the platform) of all countries involved in the project. When it is approved your own Twinspace will be opened to work with your partners.

To illustrate how the platform works I would like to introduce one of my projects.
I have joined the community for three years. Since then I involved in two international projects as a founding member. The topic of my first project was renewable resources (in more detail below in Padlet section) and the other one focused on water, hydropower generation, waterpollution and its environmental issues. In both of the projects about 100 students' work had to be coordinated. We used TwinSpace, the collaborative platform of eTwinning portal to be in contact. Students used it for sharing collected data and the results of their research work, uploading their short videos and presentations, organising video conferences, making comments how to continue team work. They could monitor the work of the rest of the students, used the chat option for quick information exchanges. Teachers involved in the project shared ideas and teaching resources, uploaded tasks, news and pieces of information related to the topic, monitored the students' work, help them through the platform if it was needed. It worked as a real social network for team work. To summarize my experience, the communication with international peer groups was extremely motivating for students.

They acquired useful information for their everyday life, deepened their knowledge in Physics and some other subjects could also be integrated into the topic, they learned how to observe and analyse scientific data. They gained confidence in communication Science and in English as well, learned how to work together, how to make evidence-based decisions or conclusions, recognised the essential features of scientific inquiry, used modern tools and techniques. Carrying out international projects is challenging not only for students but also for teachers. They are supported by eTwinning community through various professional development opportunities such as so called Learning Events, which are online courses or conferences led by experts, or teachers can join different Groups to share and exchange ideas and problems with one another to develop pedagogical competences in special areas and contexts.

2.2. Padlet

Padlet is a virtual dashboard which is perfect for organising different projects. It is good for checking the students' prior knowledge, creating mindmaps, collecting photos, sharing materials and monotoring the students' groupwork step by step. The platform is safely accessible through a web browser not only from your personal computer but also from your smartphones and tablets. It is very easy to use. The dashboard can be shared with students and colleagues involved in the project by giving a link or a QR code to sign in the board.

Introducing how we used Padlet in Physics lessons I would like to share some information about our RSIU (Renewable Sources in Use) project. It was a collaboration between a Polish Secondary School and our school, lasted for half a year. More than 100 students (aged 15-17) were involved in the project, about 70 of them from Hungary and 30 students from Poland. First we learnt some basic information related to the topic, such as sustainability, enegy generation from different renewable resources, pros and cons of their use, the problems of energy storage and environmental impacts. During the learning process students used uploaded worksheets on the Padlet as real webquests. (A webquest is an inquiry-oriented way of learning, it emphasizes the students' analytical and critical thinking skills and creativity. The worksheets contain different tasks and questions to be answered, useful links preselected by the teachers.) Students used different e-learning resources for self-learning, worked in pairs or in groups, shared their opinions and materials on the Padlet or made suggestions how to continue their working together when they got stuck. They compared the usage of renewable sources in Hungary to Europe and all over the world by data analysing, got to know the concept of ecological footprint, calculated their own footprints and compared the results to the average value in Europe. They made online surveys, evaluated the results and made conclusions and suggestions what we can do together for a better world. Based on a worksheet and given data, articles and videos in the Padlet they planed a „green"- house which works with PV system. They analysed their families' total energy demand and its monthly and daily fluctuation, the sunny hours and the irradiance in Hungary and then made calculations how many solar modules are needed to supply the family demand and determine the payback period for appliances. During the classroom activities students used their own devices (smartphones or tablets). All the materials were uploaded into the Padlet, the communication among the groups was on the platform. We used different models (Flipped classroom, project based learning, inquiry based learning, peer teaching) and varied forms of work (such as pair work, team work and also self-learning) making the classroom a dynamic environment for learning.

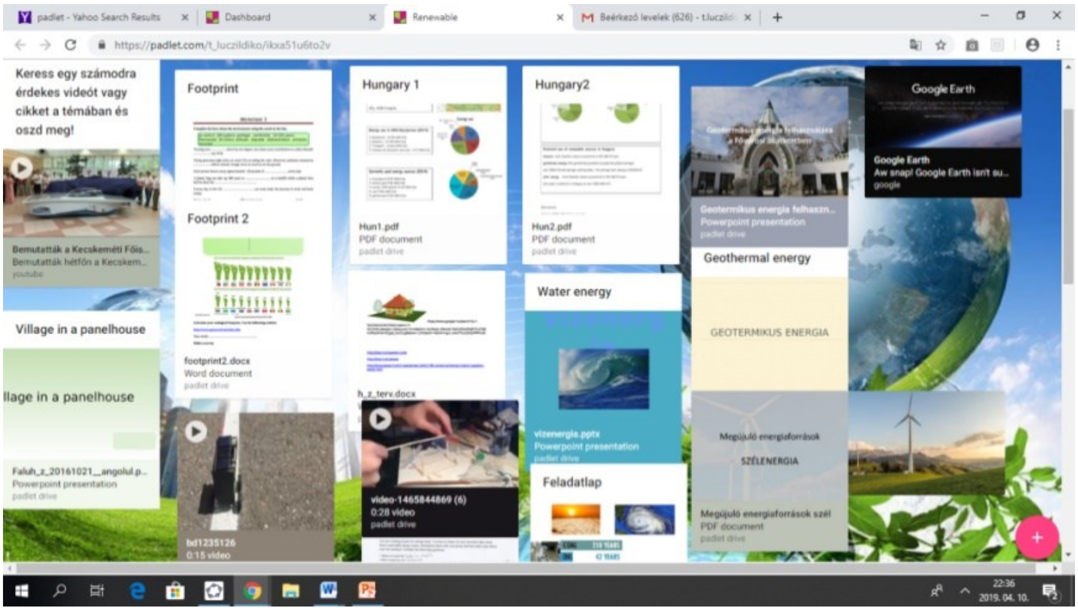

Figure 3. Dashboard of our project
(Source: https://padlet.com/t_luczildiko/ikxa51u6to2v)

2.3. GeoGebra
GeoGebra is a freely available educational software with many applications for teaching maths and science (biology, physics and chemistry) from the 1st up to the 12nd grade. Users can also create their own editable content (such as geometric edits or function plots etc.) or search for ready-to-use apps shared by others on the Geomatech platform. The GeoGebra resources are grouped by subjects and age on this portal. To introduce the way we used this app in the Physics lessons I would like to share two pieces of my experience.

2.3.1. Determination of the focal length of a convex lens. After a short warming up, basic information (principal focus, focal length, real or virtual image, inverted image, magnification etc.) about lenses were given. Then we observed how the rays of light from a burning candle standing in front of the lens form an image and how it changes by moving the candle closer and further away. It was followed by the measurement. After separating the class into six groups of four, each two groups had to examine lenses with the same parameters using different methods. First they had to study the image construction using the application and then determine the focal length of the given lens based on the lens' equation. Two groups had to measure both the object and the image distance directly, the other two groups used Bessel method [6] and the last two ones determined the focal length by GeoGebra software. The result was 12.3 cm for the first procedure 12.15 cm for the Bessel method and 12.05cm for GeoGebra. The exact value was f=12 cm. We could also observe the changes of the focal length of the lens by modifying the radius of its surface and refractive index. We could make a conclusion: the lens became thinner when the radius of its surface increased and in this case the focal lenght also increased. When the diameter of the lens increased the center of the surface approached the optical center but the focal length did not change and the focal length decreased by increasing the refractive index.

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Finally we verified the Lensmaker's equation:

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

Analysing the app at home can be an effective way of students' guided research work based on worksheets leading them step by step. Then the next lesson can be started with the discussion of the experiences. Moreover, the experiment can be repeated as many times as one wants and no experimental equipments are needed. The app is also easy to use for checking simple calculations and practising at home.

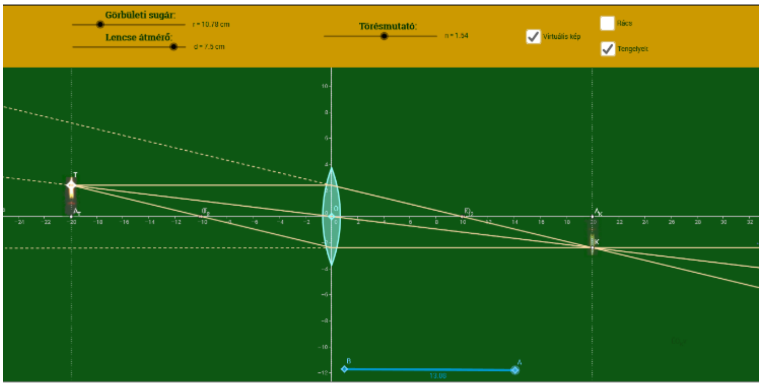

Figure 4. Measuring the focal length of a lens by GeoGebra [5].

2.3.2. Experiment to study the law of refraction. The aim of the lesson was to verify the Snell's law for refraction and to determine the index of refraction for glass both experimentally and using by GeoGebra resource, so students were separated into two groups. Those who were involved in the first group made measurements and the others in the second group observed refraction by GeoGebra. Studying refraction experimentally a laser, a semicircular piece of glass and a Hartl disc with accessories were needed. The angle of incident and of refraction ray were measured from the angle scale of the Hartl disc. The process had to be repeated with some other various incident angles. The students recorded the values of the angle of incident and of refraction ray, then plotted the graph of sin α versus sin β and found the index of refraction of glass according to the the slope of the graph and compare it to the theoretical value. Finally, they had to calculate the critical angle for glass (where $\beta = 90^{\circ}$) and check their results with the Hartl disc. During this time students in the other group had to manipulate the position of the laser in the app to change the angle of incident ray. They could record both the angle of incident and of refraction ray at the same time by pressing the button for new trials. While they added more and more data the app also generated the values of the angles' sinus and show them in a table in the bottom right corner. The ratio of sin α and sin β was calculated as well in order to verify the Snell's law. The graph of sin α versus sin β can be seen in the top right corner of the screen (figure 5). It is a straight line with a slope equal to the index of refraction. Total reflection of light can also be observed by increasing the incident angle until no light is transmitted. This allowed students to check their calculations. As we had limited time for executing the experimental work, students in the second group had more data to verify the law and their graph was much more accurate. We could compare the results of the two groups and discuss the measurement errors.

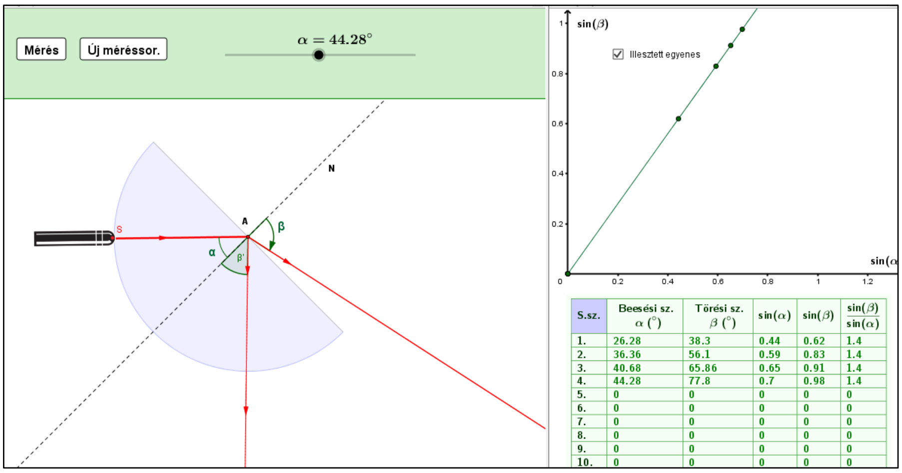

Figure 5. Verifying the Snell's law for refraction by GeoGebra [5].

2.4. StudyStack

StudyStack [2] is a flashcard maker softwer which mostly helps to memorise information in a fun and engaging way. A few games (Hangman, crosswords, buggy etc.) and various activities (quizzes, matching pairs, texts with missing words, finding synonims etc.) can be generated for studying to avoid getting bored. The app offers huge amount of ready-made flashcards in different topics but you can create your own ones based on your database. Flashcards can be used on your devices at any time and can also be printed. Sometimes I make a list of terms needed before starting a unit, create cards and let my students to play with them and learn them for a while as warming up my lessons. After then I check their newly acquired knowledge through an individual or sometimes in a team competition. Based on my experience playing against others add an extra excitement to the learning process and encourage the students to learn. The app is also useful for making revise materials and creating tasks for testing the students' knowledge. We generally use this app for self-learning or sometimes for peer teaching. In this case the class is separated into groups and then each group has to create cards for the others. After changing the cards or sharing them by giving the URL of the game with the others they get new data or terms to learn. Repeating the process several times more and more information can be acquired.

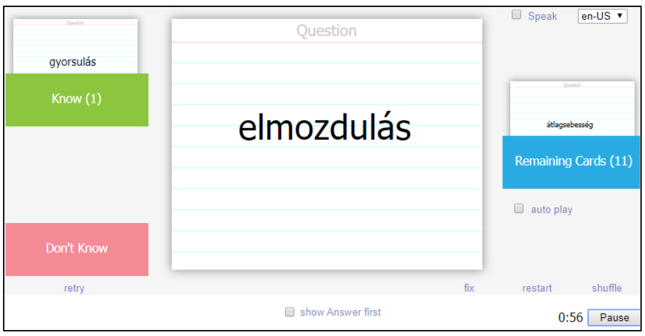

Figure 6. Clicking on the card and flipping it the answer can be checked and then the card can be signed as a CORRECT or an INCORRECT one. Finishing the first set of cards the game can be continued with the words in the INCORRECT stack until all the cards are moved into the CORRECT stack.

2.5. Kahoot and Quizizz

Nowadays Kahoot and Quizizz [3] [4] are the most popular online quizzes among students. They are very similar to each other. Both of them create an energized, game-like atmosphere in the class. Teachers are allowed to use the app in a private or a public mode. Content can be edited or you can choose a quiz created by the other members of the community. Photos, graphs, maps, short texts and videocuts can be added to the quizizzes to make them more enjoyable and colourful. Using Quizizz both questions and answers are displayed on the same device, while in Kahoot a projector is needed to project the questions and the feedback on a screen in the classroom. A time limit can be set for each questions and while playing with Quizizz the students receive them randomly. Answering a question and tapping the screen once more the user can continue the game with the next question at once. Due to the randomly chosen order of the questions and the different progression of students the app is good for testing. The app has some useful additional features for learning such as reports and homework option. Reports can be downloaded and the students' responses can be analysed question by question or by students, the worst and the best solved tasks can be highlighted and discussed. The progress of each students can be followed as the app save all the responses. Quizizzes can also be given up as a homework setting a deadline for solution. After checking the reports the next lesson can be started with the discussion of the incorrectly answered questions or the problems related to the topic. We usually use these games to warm up lessons or check the students' newly acquired knowledge at the end of the lessons. Sometimes I give them up as a homework, make the games public and share their URL with my students for practising and sometimes I use them for quick testing.

3. Conclusion

It could have happened about 7 years ago when I first noticed that my students began to loose their interests in Physics and became undermotivated. I was very upset and decided to make some changes in my teaching practice. I was looking for something new, something engaging, something effective, something modern, something that meets my students needs and expectations. At last, after many attempts, I guess I have found something that works well. This is the use of web 2.0 apps in teaching Physics combined with new pedagogical methods. Since then, some changes in my students' attitudes towards Physics can be realised as they are more active participants of the learning process. Nowadays they are happy to come to the lessons, like to participate in different projects and interested in Physics problems. Moreover, a wide range of their skills and competences were developed. During the projects students learned how to search for information from provided sources, how to analyse and share them. They learned the critical use of information, how to communicate and participate in collaborative activities and they became more responsible for their own work and also for their team work.

Acknowledgements

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