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A KOMUNIKAČNÍCH TECHNOLOGIÍ

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ÚSTAV JAZYKŮ

POPULARISATION OF SCIENCE IN THE CZECH REPUBLIC

POPULARIZACE VĚDY V ČESKÉ REPUBLICE

BACHELOR'S THESIS

BAKALÁŘSKÁ PRÁCE

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VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
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Bakalářská práce

bakalářský studijní obor **Angličtina v elektrotechnice a informatice**

Ústav jazyků

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NÁZEV TÉMATU:

Popularizace vědy v České republice

POKYNY PRO VYPRACOVÁNÍ:

Cílem práce je zjistit aktuální situaci týkající se popularizace vědy v České republice, popsat ji a provést šetření o povědomí veřejnosti o možnostech popularizace vědy následované vytvořením popularizačně naučného programu zaměřeného na elektrotechnické jevy.

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Abstract

The Bachelor´s thesis deals with the theme of popularisation of science. The aim of this thesis is to determine the subjects dealing with popularisation of science and to discover the public awareness of the topic. The first part of the thesis focuses on the definition of the term popularisation of science. In the second part the difference between learning of an adult and a child is discussed. The third part shows the subjects of popularisation of science and the following chapter, which is based on a questionnaire, describes the specific knowledge of the inhabitants of Brno and its surroundings about the possibilities of popularisation of science. The final chapter is devoted to the creation of a popularising and educational program concerned with the topic of electricity and magnetism.

Keywords

Awareness, electricity, learning, magnetism, popularisation of science, program, public, science centre, subjects of popularisation of science.

Abstrakt

Bakalářská práce se zabývá tématem popularizace vědy. Cílem práce je definovat subjekty zabývající se popularizací vědy a zjistit informovanost veřejnosti o daném tématu. První část práce je zaměřena na definici termínu popularizace vědy. V druhé části jsou popsány rozdíly v učení dospělých a dětí. Třetí část ukazuje subjekty popularizace vědy a následující kapitola, založená na dotazníku, popisuje povědomí obyvatel Brna a jeho okolí o možnostech popularizace vědy. Závěrečná kapitola se věnuje tvorbě popularizačně naučného programu zaměřeného na téma elektřina a magnetismus.

Klíčová slova

Elektřina, magnetismus, popularizace vědy, povědomí, program, subjekty popularizace vědy, učení, veřejnost.

HOLČAPKOVÁ, M. *Popularizace vědy v České republice.* Brno: Vysoké učení technické v Brně, Fakulta elektrotechniky a komunikačních technologií, 2019. 57 s. Vedoucí bakalářské práce PaedDr. Alena Baumgartnerová.

Prohlášení

Prohlašuji, že svou bakalářskou práci na téma *Popularizace vědy v České republice* jsem vypracovala samostatně pod vedením vedoucí bakalářské práce a s použitím odborné literatury a dalších informačních zdrojů, které jsou všechny citovány v práci a uvedeny v seznamu literatury na konci práce.

Jako autorka uvedené bakalářské práce dále prohlašuji, že v souvislosti s vytvořením této bakalářské práce jsem neporušila autorská práva třetích osob, zejména jsem nezasáhla nedovoleným způsobem do cizích autorských práv osobnostních a jsem si plně vědoma následků porušení ustanovení § 11 a následujících zákona č. 121/2000 Sb., včetně hmotných trestněprávních důsledků vyplývajících z ustanovení části druhé, hlavy VI. díl 4 Trestního zákoníku č. 40/2009 Sb.

V Brně dne ....

Martina Holčapková

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Contents

1 Introduction

In recent years science is becoming more and more important. Because of modernisation more researches are being carried out. Lately, it has become essential to understand science or at least to its basics.

In 2007 ScienceDaily publicized research about scientific literacy in America (data by Michigan State University). This research showed that "70 % percent of Americans cannot read and understand the science section of the New York Times." (Michigan State University, 2007) They also stated that "approximately 28 percent of American adults currently qualify as scientifically literate." (Michigan State University, 2007)

As a reaction to the findings which can be seen above, David Ewing Duncan wrote in his article that "this level of science illiteracy may explain why over 40 percent of Americans do not believe in evolution and about 20 percent, when asked if the earth orbits the sun or vice versa, say it's the sun that does the orbiting." (Duncan, 2007)

Although these findings are from the beginning of the twenty-first century and even though nowadays there are still people who do not understand science, things seem to change for the better. Popularisation of science helps people understand the basics and motivate them to learn more. In spite of the fact that there are many subjects engaged in this field, it is not very well known. That is the reason I would like to find out more.

Research about popularisation of science in the Czech Republic will be carried out in this Bachelor´s thesis. First, the popularisation of science will be defined. To be able to talk about the subject of popularisation of science, the differences between adult and child learner will be specified. Because there are not many books regarding subjects of popularisation of science, the subjects will be determined by research done on the internet. A huge number of subjects engaged in this field exists but this Bachelor´s thesis will mainly concentrate on science centres. To conclude this research, a questionnaire study will be carried out. The questionnaire will be concerned with the knowledge of the general public about the possibilities of popularisation of science. This questionnaire will be focused on popularisation of science in Brno.

After the research is conducted, a popularising and educational program focused on electricity and magnetism will be created.

2 Popularisation of science

Science and technology are both important parts of our life, but not everybody understands it. Popularisation of science is a huge phenomenon and it is becoming widely spread in recent years. In a lecture given by G. Giacomelli and R. Giacomelli (2014) was said that Gianni Puppi used to say: "If you are not able to explain to your aunt in less than 5 minutes what you are doing in physics, then you have not really understood what you do." (p. 3) This is basically the key thought of popularisation of science. Václav Cílek (2016) defines popularisation of science as following: "Popularisation of science is a type of service within a given field, to a community or to a nation. It consists of transforming complex scientific language into generally comprehensible form and putting the specialised knowledge into a general context. Its goal is to inform about what is happening in a given field, expand common education and create informed, critical, and aware society." (p. 2, translated) It means that whoever is the one propagating science, they must understand it and be able to reproduce it to anyone in a way the person would understand it and remember it, regardless of the age or the background knowledge. The way to achieve this is usually connecting the information with something the audience already knows and comprehends the way how it works. Another important thing is to give them information in an interesting way.

Popularisation of science is not about learning something by heart, because it is believed that nobody would remember it in the long term. This is not a way to learn things and the subjects of popularisation of science try to make it differently.

Table 1: The percentage of remembering according to the way of learning (Malach, 2003, p. 47, translated)

How much does a person remember	Receptor of perception, activity
20 %	from what they hear
30 %	from what they see
50 %	from what they see and hear
70 %	from what they are talking about
90 %	from what they are doing

As can be seen in the Table 1 there is a significant difference on the amount the person will remember with respect to the way of learning. Logically, when it is desired for the person to remember as much as possible (and understand it) it is essential for them

to experience it themselves. This is an important aspect which can be seen for example in science centres. It can be achieved through exhibitions or experiments. Not every subject of popularisation of science can achieve this, but the effort to teach as much as possible in a comprehensive manner remains.

The basic questions that every good lector should ask themselves are similar to the ones that a subject of popularisation of science should ask itself. Josef Malach (2003) states that it is important to know if the listener has a good feeling from the lecture, if they will remember information they learned, if they would come again and of course if their will ever use the knowledge in their life. If the lector (or subject of popularisation of science) can answer yes and can do it effectively in the shortest time possible, then it was a time well spent to teach people new information.

3 Differences in approach to children and adults in terms of educational and popularising program

There are two fields which focus on teaching: pedagogy and andragogy. In Cambridge dictionary (n.d.) following definitions of these words can be found: pedagogy is "the study of the methods and activities and teaching" and andragogy is "the theory, methods, and activities involved in teaching adult learners." The word pedagogy comes from "paidi (child) + ago (guide)" (Pappas, 2015), while andragogy comes from "andras (man) + ago (guide)" (Pappas, 2015). From these definitions can be seen that pedagogy concentrates on teaching children and andragogy on teaching adults. Same as in ordinary teaching, the difference is also in the field of popularisation of science.

Many subjects try to make the science available for everyone – with no regards towards the age of their audience. This can be seen for example at exhibitions or science shows in science centres and at Researchers´ Night. Then there are subjects that focus on a specific group – for example videos by Zvědátoři are content on the YouTube platform aimed towards children and teenagers. But when discussing educational and popularising programs the differences between learning of children and adults must be considered. A child will not understand a program that is made for adults and an adult will not be interested in a program made for children. This is something that must not be forgotten.

As Kristýna Moravcová[1] experienced, there are two main differences between learning of an adult and a child. An adult learner is learning because they want to, meanwhile a child must be motivated by a lector. Also, an adult has many experiences to build on, while the child does not. This must all be considered. When making a program for adults it is important not to be childish. It must be specific and scientific. A lector is there only to help the adult to achieve the goal, to help them with the process if needed. In case of a program for children it is more difficult. The program must work with what the child knows. It must be simple, but still the goal is to teach the child something and ignite a passion for them to continue finding out more about the theme. The best way to do this is to guide the child through the program and describe it to them in a simple and mainly

[1] Kristýna Moravcová works as edutainer in VIDA! science centrum in Brno. She has many experience – besides working in exhibition, she prepares and does summer camps for children, she does science shows, she prepares themed events for adults, she does programs for children, and goes on promoting events. All the information was obtained during an interview in November 2018.

interesting way while using comparisons with things they already know. In this case, it is essential to keep the program as short and concise as possible to retain the attention of the child.

4 Subjects of popularisation of science

Regarding the popularisation of science, there are many methods on how to achieve the goal of reproducing the science to the public. No subject can do all of them and that is why there is a big amount of different methods to introduce science to general public and also many subjects concerned with this field. Every subject has a slightly different method to teach the public, but the objective remains the same.

Particularly in the Czech Republic there can be found:

- science centres
- special events
- individual people or small companies
- summer camps
- free-time activities
- books
- internet websites
- TV shows, etc.

4.1 Science centres

As stated at almost every science centre's website, this place of informal education is for everyone. The method of science centres is to teach through experience, which is the best way to learn new information. As already mentioned in the chapter two, learning by trying themselves means the person will remember up to 90 % of the information. Every science centre has an exhibition where people can interact with exhibits by themselves and learn something new by finding out how it works and by reading more information about it. The best outcome would be people being inspired by the exhibits and wanting to find out more about the phenomena they have just discovered. As regards the exhibits the emphasis is being put on interactivity and experience.

Science centres are about more than exhibits. Apart from that, there can be found programs for schools, science shows, special workshops, themed events, etc. This is something that does not apply to all the science centres in general, but it is different in each place. Some of the science centres can even have an outdoor exhibition or a planetarium.

In science centres there are well-informed employees waiting to be asked by visitors for more information or to help them understand the exhibits. These people are called edutainers which comes from English words “educate” and “entertain” (Česká asociace science center, n.d.).

It is believed that the first science centre is Urania, founded in 1888 in Berlin. It lasted many years since then until the first science centre in the Czech Republic was founded. There were some thematic parks, but the first Czech official science centre was iQPARK in Liberec founded in 2004 (Česká asociace science center, n.d.). After that more science centres were established.

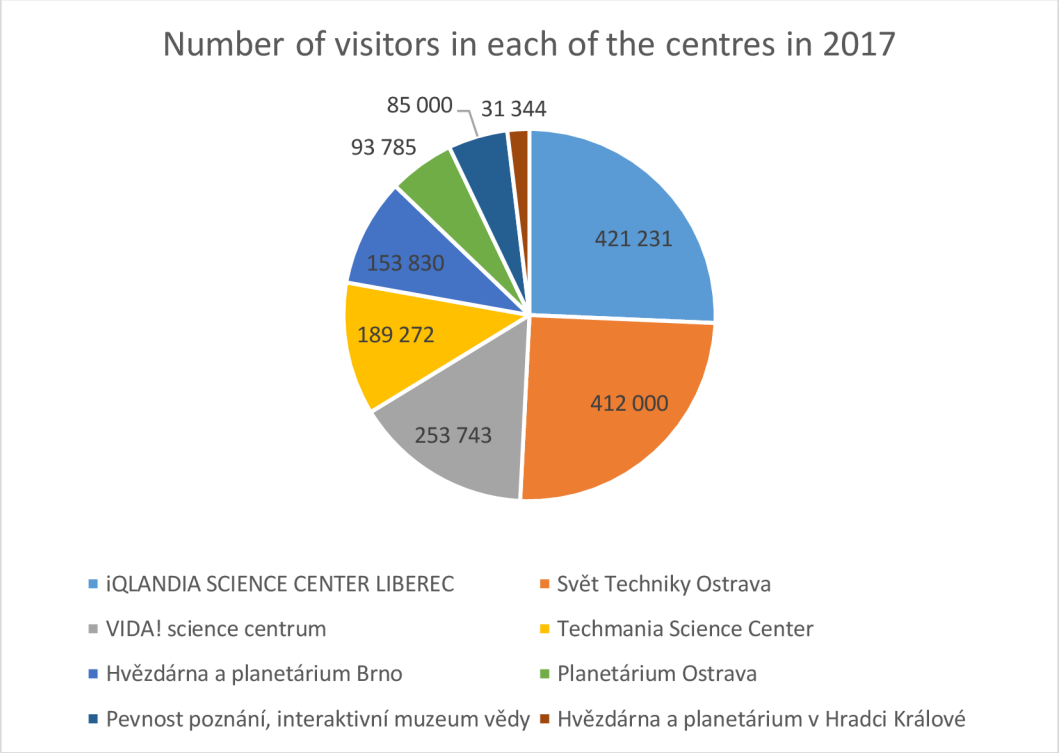
Science centres are usually under a patronage of a bigger organization. The most known are ECSITE - European Network of Science Centres and Museums and ASTC - Association of Science-Technology Centers (Broulíková, 2013). In the Czech Republic the organization is called Česká asociace science center[2] and it includes science centres and planetariums.

To the year 2018 following subjects belong to the organization (Česká asociace science center, n.d.):

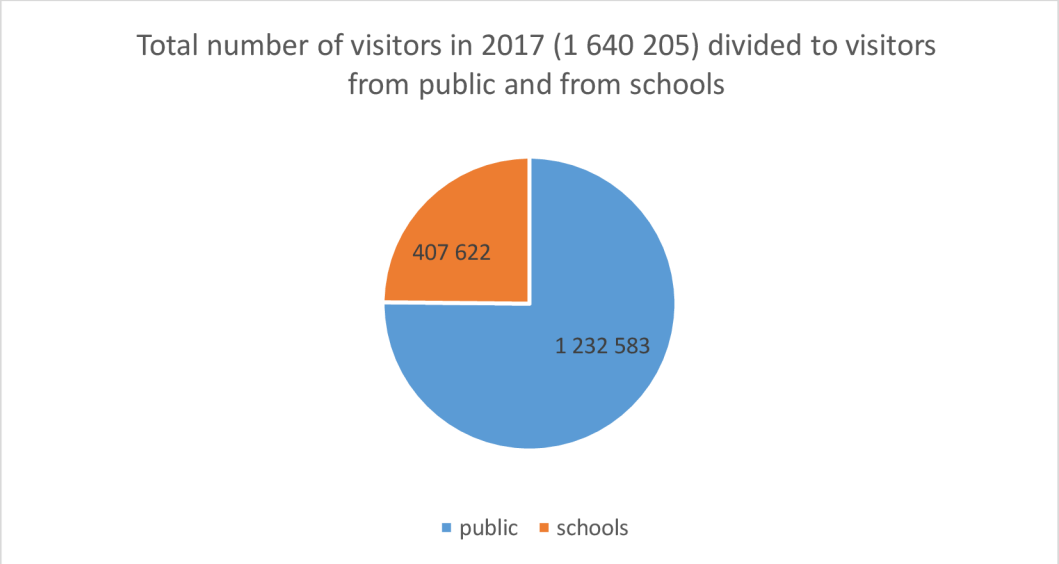
- Hvězdárna a planetárium Brno[3]
- Hvězdárna a planetarium v Hradci Králové[4]
- iQLANDIA SCIENCE CENTER LIBEREC
- Pevnost poznání, interaktivní muzeum vědy[5]
- Planetárium Ostrava[6]
- Svět techniky[7]
- Techmania Science Center
- VIDA! science centrum[8]

At the website of Česká asociace science center a lot of information can be found. One of the most important and most interesting ones is in its annual reports. It is the record of number of visitors.

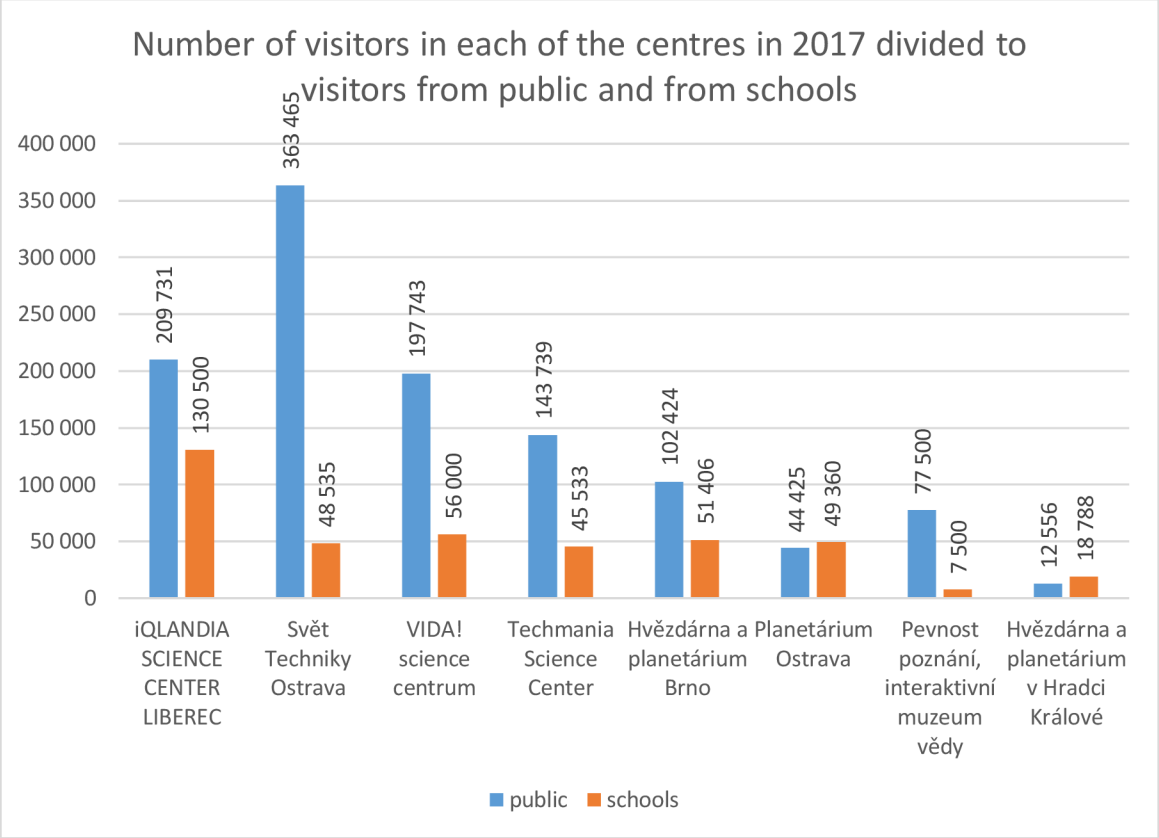
[2] Czech Association of Science Centers
[3] Brno Observatory and Planetarium
[4] Observatory and Planetarium in Hradec Králové
[5] Fort Science, interactive museum of science
[6] Planetarium in Ostrava
[7] Science and Technology Centre Ostrava
[8] VIDA! Science Center



Graph 1: Number of visitors in each of the science centres in 2017
(data by Česká asociace science center, 2018)



Graph 2: Total number of visitors in 2017 (1 640 205) divided to visitors from public and from schools
(data by Česká asociace science center, 2018)



Graph 3: Number of visitors in each of the centres in 2017 divided to visitors from public and from schools (data by Česká asociace science center, 2018)

As can be seen in the graphs more than 1.5 million people visited science centres / planetariums associated under Česká asociace science center last year. About 400 visitors were students who came to the science centre instead of a lesson. The most visited science centre by regular visitors was Svět techniky and the one most visited by school groups was QLANDIA SCIENCE CENTER LIBEREC. In general, science centres were visited more than planetariums.

4.1.1 iQLANDIA SCIENCE CENTER LIBEREC

iQLANDIA SCIENCE CENTER can be found in Liberec. It was founded in 2014. It is located in a building that consists of 6 floors with 10 different interactive exhibitions: Geolab, Kosmo, Vodní svět,[9] GEO, Živly,[10] TULaborka, Člověk,[11] Věda v domě,[12] Češi

[9] Water World
[10] Elements
[11] Human
[12] Science in the Home

světu,[13] and Sexmise[14]. All the exhibitions but Sexmise are permanent. Sexmise is a temporary exhibition. There are also solar terraces, a place for relaxation, and laboratories. The science centre is for everyone who is interested in finding out something new about science.

The building of the science centre can be seen in the Figure 1. Figure 2 shows one of the exhibitions.

Figure 1: Building of the science centre – photo: © iQLANDIA SCIENCE CENTER LIBEREC

(Retrieved from: http://www.iqlandia.cz/cz/iqlandia/fotogalerie/budova)

Figure 2: Exhibition - photo: © iQLANDIA SCIENCE CENTER LIBEREC

(Retrieved from: http://www.iqlandia.cz/cz/iqlandia/fotogalerie/expozice)

[13] Czechs of the Word
[14] Sexmission

In laboratories workshops take place. They can be visited during the weekends and national holidays. It is for free, but the visitor should book their place at the cash desk. Another activity to visit is a science show which takes place every day. In iQLANDIA they have two different science shows: Malá science show and Velká science show.[15] Beside this, there are activities in the exhibition. To this category belong: Seznam se s nanovláknem,[16] Lego Mindstorms, Testování smyslů,[17] and Život s bílou holí.[18] Also a planetarium with a wide offer of movies can be visited.

This science centre has a number of activities for schools. It offers programs for schools, science shows, movies in planetarium, exercise sheets to all the exhibitions, and even a day to tighten up the group. There is a choice of many programs and science shows on different themes. The themes are set according to the School Educational Programme and sorted out according to the age groups. To give an example - a science show Na vlnách zvuku[19] or Astrofyzika[20] can be chosen.

iQPARK, the first science centre in the Czech Republic founded in 2004, is a part of this science centre. It can be found across the street in Babylon centre and it is meant for children. There are four floors with four exhibitions: Malá věda,[21] Svět kolem nás,[22] Schopnosti a dovednosti,[23] and Vodní svět, klamy a hlavolamy.[24] Besides exhibitions science shows (Malá science show, Velká science show) and laboratories (Hravá laboratoř[25]) can be found here. As in iQLANDIA thematic science shows, workshops, and list of exercises are offered. The only difference is that it is for small children.

For companies a rental is offered. It does not matter what the purpose is (if it is for teambuilding, Christmas party or anything else that can be thought of) a part of the science centre or even the whole building can be rented. If the company wants a program but does not want to travel to the science centre, there is also an offer of science shows, thematic games, experiments, and travelling exhibitions at any place the company

[15] Small Science Show and Big Science Show
[16] Meet Nanofiber
[17] Testing of Senses
[18] Life with a White Stick
[19] On the Waves of Sound
[20] Astrophysics
[21] Small Science
[22] World around Us
[23] Abilities and Skills
[24] Water World, Illusions and Puzzles
[25] Playful Laboratory

wishes. Travelling exhibitions vary from 10 to 63 exhibit. Interested person can choose from following exhibitions: Hry a klamy,[26] Poznávej se[27] (exhibits about human senses), and iQLANDIA (exhibits in the theme of natural sciences).

4.1.2 Pevnost poznání, interaktivní muzeum vědy

Pevnost poznání, interaktivní muzeum vědy or as it is called in English – Fort Science, interactive museum of science is an interactive science centre which was founded in 2015 in a former artillery warehouse in Olomouc. It belongs to the faculty of natural sciences of Palacký University of Olomouc.

There are four permanent exhibitions: Věda v pevnosti,[28] Živá voda,[29] Rozum v hrsti,[30] and Světlo a tma[31] (see exhibit from this exhibition in the Figure 3). In these exhibitions visitors can learn about the history of the fort, watch organisms under a microscope, go into an 8 metres huge brain, try a gyroscope, or see how the light originates.

Figure 3: Exhibit from Světlo a tma – photo: © Pevnost poznání

(Retrieved from: https://www.pevnostpoznani.cz/expozice/)

[26] Games and Illusions
[27] Get to Know Yourself
[28] Science in the Fort
[29] Living Water
[30] Wisdom in the Hand
[31] Light and Darkness

There are three possible activities to visit at a planetarium. It is possible to see a movie projection, program, and static exhibition of astronomy and cosmonautics. There are 6 educational and popularising movies to choose from. As part of the program in the planetarium, the lector will show the night sky and star constellation to the visitors. The static exhibition is about the distances between planets. Also, a timeline of the universe (including the future) can be seen there.

Traditionally, this science centre offers programs for schools. Programs are divided by subjects – physics, geography, mathematics, chemistry, biology, history, and bonus programs which are concerned with current topics. Each program is prepared for a different age group. The classical programs take 45 minutes, the duration of the programs concerned with current topics differs.

In case someone wants the science to come to them, it is possible - at least partially. Pevnost poznání offers "off-site packages". The offer consists of workshops (Fyzikální laboratoř,[32] Chemická laboratoř,[33] Biologická labortoř,[34] 3D tisk,[35] Výtvarná dílna[36]), science shows, and rental of exhibits (Ježek v kleci[37], 3D piškvorky[38], Míchání barev[39], Mimozemšťan[40]).

The thing in which this science centre differs from others is Spolek Pro poznání[41] which is for seniors. As Pevnost poznání (n.d.) states on their website "brain has a spectacular quality – neuroplasticity. It is an ability to create new connections and tracks between existing neurons. By goal-directed training we can strengthen or restore its abilities. Researches prove that for the development of the brain is important not only the mental activity, but also the physical." This is the idea on which this society is based on. In three-semester course seniors do activities which help them to keep active in both mental and physical aspects of life. In the course seniors learn positive psychology, they attend physiological lessons, or even learn how to juggle.

[32] Laboratory of Physics
[33] Laboratory of Chemistry
[34] Laboratory of Biology
[35] 3D printing
[36] Art Workshop
[37] Hedgehog in a Cage
[38] 3D tic-tac-toe
[39] Mixing of Colours
[40] Alien
[41] Society for Recognition

Pevnost poznání offers other things as are rentals, summer camps, free-time activities, scientific-artistic workshop, children university, cruises of recognition, the possibility of birthday parties for children, and comic books for children.

4.1.3 Svět techniky[42]

Science centre Svět techniky was opened in 2014 in Dolní Vítkovice in Ostrava. It is divided into Velký svět techniky[43] and Malý svět techniky.[44]

Velký svět techniky has 12,000 m^2, where 4 permanent and 1 temporal exhibitions can be found. Permanent exhibitions (or světy[45] as they call them) are Dětský svět,[46] Svět vědy a objevů[47] (see Figure 4 for an exhibit from this exhibition), Svět civilizace,[48] and Svět přírody.[49] In November 2018 the temporal exhibition was Klamárium, which is an exhibition with optical illusions prepared by Psychologický ústav Akademie věd České republiky.[50]

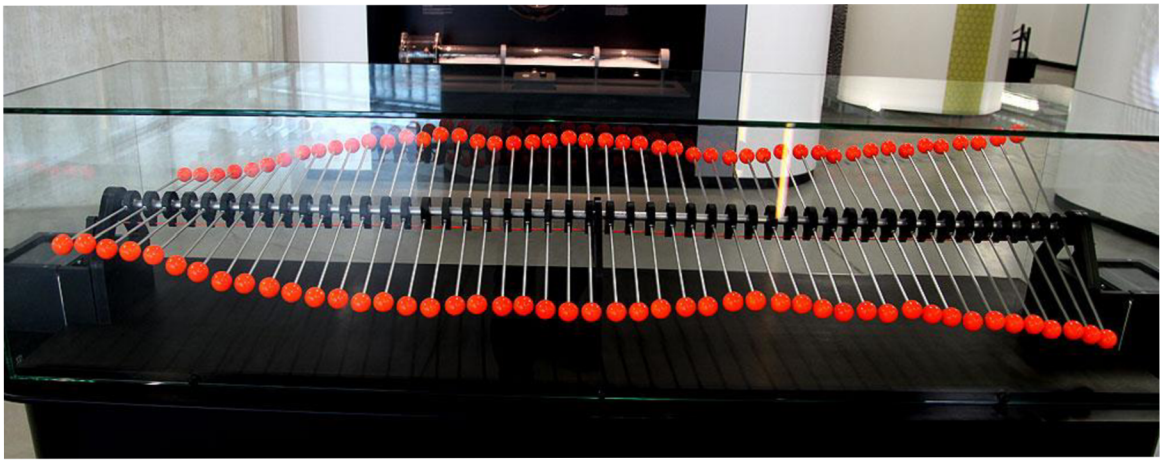


Figure 4: Exhibit from exhibition Svět vědy a objevů – photo: © Svět techniky Ostrava

(Retrieved from: http://stcostrava.cz/vlnostroj)

[42] Science and Technology Centre Ostrava
[43] Science and Technology Centre
[44] U6 Science and Technology Centre
[45] worlds
[46] Children´s World
[47] World of Science and Discoveries
[48] World of Civilization
[49] World of Nature
[50] Institute of Psychology od Czech Academy of Sciences

In the Divadlo Vědy[51] on the third floor, different science shows which last 30 minutes can be seen. These are Let´s go science (gaseous show), Plameny vědy[52] (fiery show), Budiž světlo[53] (luminous and UV show), Elektrizující zážitek[54] (electrical show), Hrátky se zvuky[55] (sound show), and Science Maglajz (a mixture of three thematic blocks).

Malý svět techniky is in an industrial building – VI. Energetická ústředna.[56] By the words of Svět techniky (n.d.), in this part of the science centre visitors can "uncover the mysteries behind technological inventions and witness the timeline of technological progress from the age of industrial revolution until now." Besides that, there are accompanying programs and commented tour can be booked.

Visits to exhibitions Velký svět techniky or Malý svět techniky are offered for schools. Beside that. programs for different age groups focused on different subjects can be ordered.

4.1.4 Techmania Science Center

The history of Techmania Science Center is strongly connected with ŠKODA HOLDING a.s. company and Západočeská univerzita v Plzni. In 2005 they established Regionální technické muzeum o.p.s, which is a company created to run a science centre. ŠKODA HOLDING a.s. donated an old building to the company. From 2006 Techmania started with activities that popularised science and after a part of the building was reconstructed it was opened in 2008 as a new science centre.

When the science centre was opened, it had 4 exhibitions: Edutorium, MáToHáček, Expozice Škoda[57], and Patentováno přírodou[58]. The last exhibition mentioned was then replaced by TOP SECRET exhibition. In 2008 there could be found Pod hladinou[59], Století

[51] Science Theatre
[52] Flames of Science
[53] So Be Light
[54] Electrifying Experience
[55] Plays with Sound
[56] The VI. Industrial Centre
[57] Exhibition ŠKODA
[58] Patented by Nature
[59] Under the Surface

budov Techmanie[60], Expozice ČT:D[61], Chemistři[62], Vzhůru dolů[63], Budoucnost na talíři[64], Expozice Vesmír[65], MáToHáček, Vodní svět[66], Edutorium, Malá věda[67], Entropa, and 150 let průmyslu v Plzni[68]. Since 5 October, 2018 there is also an exhibition called Člověk a zvíře[69]. In these exhibitions visitors can compare their abilities with the ones of animals, create waves, see the Jacob´s ladder or Van de Graaff generator. The smallest visitors can enjoy crossing a river on a rope or play the harp with invisible strings.

For the ones who are interested in a movie there is 3D Cinema with beanbags to sit on. Beside that 3D Planetarium with adjustable seats is there and astronomical objects or cornerstones of life can be seen there. Techmania Science Center (n.d.) describes that "all this is shown in a unique dome with an internal diameter of 14 meters. The projection itself has one of the finest 3D resolutions in the world. Only three European Science Centers currently have this sophisticated 3D projection technology by Sky-Skan: Centrum Nauki Kopernik in Warsaw, Barcelonian CosmoCaixa and the Techmania Science Center in Plzeň."

Figure 5: Science on a Sphere – Photo: ©Techmania Science Center, o.p.s

(Retrieved from: https://www.dropbox.com/sh/rs98wgp0xjep588/AABuzCRUZBXsPHLJI2M-8Z7ga/4%20science%20on%20a%20sphere?dl=0&preview=techmania_science_on_a_sphere_04.jpg&subfolder_nav_tracking=1)

[60] A Century of the Buildings of Techamia
[61] ČT:D Exhibition
[62] Masters of Chemistry
[63] Let´s Head Down
[64] Future on a Plate
[65] Exhibition Universe
[66] Water World
[67] Small Science
[68] 150 years of the Industry in Plzeň
[69] Human and Animal

Interesting thing other Czech science centres do not have is a "Science on a Sphere." It is a huge globe which can be controlled by movements of hands and short movies or animations can be displayed there. See Science on a Sphere in the Figure 5.

Accompanying science shows can be attended. In this category belong a science show with liquid oxygen, trying to sit in a huge and moving gyroscope, daytime astronomical observation, demonstration of steam machine MARX, and experiments with Van de Graaff generator.

As in every Czech science centre programs for schools are offered. Besides that lists with exercises can be found on the website of Techmania Science Center. Both offers are divided into age groups and then in groups according to what they want to do – visit the exhibition, see a science show or for example to have a program with a lector.

An educational portal can be found on https://edu.techmania.cz/. This portal is provided by Techmania Science Center and is meant for kindergartens, elementary schools, high schools, universities, and for the general public. On this portal there can be found offers of this science centre, encyclopaedia, and news.

In Techmania Science Center group for kids called Koumáci has a room for their activities and rentals are offered.

4.1.5 VIDA! science centrum

VIDA! science centrum is a science centre which is located in Brno in a former D pavilion of the Brno Exhibition Centre. The area of this science centre is nearly 5,000 m^2 and the centre was opened at the end of 2014.

When opened there were 151 exhibits, now it is more than 170 exhibits. In the Figure 6 there is a view of the exhibition. The exhibition is divided into 5 thematic parts which are Planeta,[70] Civilizace,[71] Člověk,[72] Mikrosvět,[73] and Dětské science centrum.[74] In each part, there can be found many interactive exhibits visitors can try. To name some there is tornado, earthquake, electric arc or interactive sandbox.

[70] Planet
[71] Civilization
[72] Man
[73] Microworld
[74] Science Centre for Children

All the exhibits have a list of information which is in Czech, English and German. There is also a place for temporary exhibitions. In past exhibitions called "Klamárium" with optical illusions and "Cirkus Mechanikus" with mechanical machines were there. Dětské science centrum is just for children as can be seen in the name, but the rest is for everyone – for both children and adults.

Figure 6: Exhibition – photo: © VIDA! Science centrum

(Retrieved from: https://vida.cz/pro-media)

Themed events for families take place a few times a year. There are special activities connected with a given theme. Every year there is Bastlfest – festival of DIY, Čarodějná škola[75] – a day in costumes with thematic lab experiments, or Narozeninový víkend.[76]

That were themed events for families with children, but there are also events only for adults. It is called VIDA! After Dark and it is strictly for people who are 18 years old or older. There is a bar with alcohol, music and thematic program (which might not be suitable for children). These events take place irregularly, usually every month of an academic year. On Wednesday 31 October, 2018 Halloween VIDA! After Dark took place. According to the website of VIDA! science centrum whoever came in a costume had a discount in a price. There were a horror lab, eye and heart dissection and especially bloody science show. (VIDA!, n.d.)

[75] School of Witches and Wizards
[76] Birthday Weekend

From everyday activities, Science shows and 3D movies should be mentioned. Science shows are the same during a couple of days and then they change. In October 2018 they were Mr. Ucho[77] (a show about sound) and Kolo[78] (a show about bicycles). In the science shows thematic experiments can be seen – see Figure 7. Regarding 3D movies in October 2018 there was a possibility to see Predátoři[79] and Pidiobři.[80]

Figure 7: Science show – photo: © VIDA! Science centrum

(Retrieved from: https://vida.cz/pro-media)

Bastlírna and Pevnost VIDArd[81] are both something extra to try in the science centre. Tinkering studio Bastlírna is opened every day and boundaries for the visitor´s fantasy are not set here. Pevnost VIDArd is a game that can be bought at the cash desk and it enables people to see the exhibition from a different point of view. If it is solved correctly, the visitor will find a treasure at the end of the game.

Every weekend labs for families take place, where children can try experiments prepared for them. During school year free-time activities are offered. And when are school holidays, there is a possibility to go to a camp where lectors provide an educational program for children.

During school year programs for schools with well-educated lectors are offered. In school year 2018/2019, there was a variety of 22 programs. Every program is for a given

[77] Mr. Ear
[78] Bicycle
[79] Incredible Predators
[80] Tiny Giants
[81] Fort VIDArd

age group and it is focused on a part of School Educational Programme. As an example, program called Světelná laboratoř[82] can be mentioned. This program concentrates on the methods how the light originates and students will try experiments connected with it. This program is for the lower secondary school and for secondary schools and the theme belongs into chemistry, physics and natural history.

For special occasions, there is a possibility of rentals. It is possible to choose from several rooms for rent or even to rent the whole centre. In case of interest, a science show or 3D movie projection can be added to the rental.

Birthday parties for children can take place in the centre. Birthday party in VIDA! science centrum consists of renting a room and visiting the exhibition. Also, an edutainer to create a program for children can be hired.

4.2 Special events

In the Czech Republic many educational and popularising events take place. The most known ones are Noc vědců[83] and Týden vědy a techniky[84] that are both for free.

Noc vědců takes place both in the Czech Republic and in the rest of Europe from 2005. Every year it takes place on the last Friday of October. Barbora Černíková describes that "the aim of this event is to present the scientists to the public as ′ordinary people′, to show that science can be fun, and to persuade the visitors that maybe even they can try to devote to scientific career." (Stejskalová, 2009, p. 13, translated) There are no boundaries to what activities can the places that take part in prepare. Among the activities experiments, quizzes, and visits to laboratories can be found.

When this event started (in 2005) 13 European countries took part. In the Czech Republic only 2 places participated. In 2009 it was already 30 countries and 7 places in the Czech Republic. In 2018 more than 30 places in 15 cities in the Czech Republic participated – among them there were for example universities, science centres, and research labs. In 2018 60,000 visitors attended.

[82] Laboratory of Light
[83] Researchers´ Night
[84] Week of Science and Technology

Týden vědy a techniky is under the patronage of Akademie věd České republiky[85]. During this event there were more than 500 smaller events in the whole Czech Republic in 2018. The website states that "Týden vědy a techniky Akademie věd České republiky is the biggest scientific festival in the Czech Republic which includes seminars, exhibitions, activities at work places, documentary movies, workshops, scientific cafeterias, and many other activities across the whole republic and across all the scientific fields." (Týden vědy a techniky AV ČR, n.d., translated) In 2017 there were 659 events which were visited by 58 331 visitors.

Akademie věd České republiky has a leading role in the popularisation of science in the Czech Republic. Besides organising Týden vědy a techniky, they organize cycles of seminars for students and high school teachers, they organize thematic exhibitions, they publish magazines, they make videos about science, they have their own cycle of educational and popularising videos called NEZkreslená věda[86], and they offer internships for students. They also offer summer camps and courses which are for teachers and general public.

4.3 Other subjects

Not every subject is a big organisation. As an example that it is not a rule Michael Londesborough, Zvědátoři[87], and ÚDiF can be mentioned.

Michael Londesborough comes from Great Britain. Now he works as a delegate of a project called Otevřená věda Akademie věd České republiky[88] - it is a project aiming on popularisation of science which is under Akademie věd České republiky. He wrote many scientific papers and attended many projects aiming on popularisation of science. Besides that he worked for Česká televize[89] – he filmed educational and popularising videos for a show called Port which was about news from science.

[85] Czech Academy of Sciences
[86] The name is a worldplay coming from words undistorted and cartoon + science
[87] The name is a wordplay coming from words curious and scientists
[88] Open Science of the Czech Academy of Sciences
[89] Czech Television

Zvědátoři is a name of duo Martin Rota and Patrik Kořenář. They are "youtubers" and they post videos from their show called "Proč to řešíme?"[90] on YouTube. They do not focus on one field, but they choose a different one every time.

ÚDiF alias Úžasné Divadlo Fyziky [91] is a group of people who decided to popularise physics. They perform science shows with the intent to inspire the people to go and experiment by themselves. They offer science shows and workshops for schools and companies. Besides that, they have a small online shop with interesting material (as polarising foil) and they publish educational and popularising videos called Badatelna.[92]

What was mentioned above is not at all everything that can be found in the Czech Republic. Some of the subjects are small, some are bigger. There are summer camps that are usually organized by science centres. Some of them are organized by a different organization, for example by a ZOO. Also, there are free-time activities and summer camps organized by veselaveda.cz. Educational and popularising books, TV series, and videos on the internet can be also found. In recent years universities take part in popularisation of science – beside their own activities they take part in Noc vědců. One of the activities of universities is for example "Elektrikárium" at Brno University of Technology, where there are 15 interactive exhibits which concentrate on electricity, electrical engineering, and related fields. Another example is Science slam which is an event organized by Masaryk University, where scientists speak about themselves and their work.

[90] Why do we deal with it?
[91] Amazing Theatre of Physics
[92] Place for Exploring

5 Results of the questionnaire study about the knowledge of public about the possibilities of popularisation of science in Brno

To determine the knowledge of public about the possibilities of popularisation of science in Brno an online questionnaire (in both English and Czech language) was created. This questionnaire was distributed online via friends and family to the public. The target group were people living in Brno and its surroundings who do not work (and did not work in the past) in the field of popularisation of science. As the result, I received 78 answers. Two of the answers had to be eliminated, one because the person did not read the instructions and the second one because I did not specify the target group well enough. Because of the small number of answers results offer us only an overall idea about the knowledge of the public.

Every person had to state if they are high school student, university student, adult or pensioner. I excluded younger people because they were not subjects of my research. I received responses from 4 high school students, 20 university students, 49 adults and 4 pensioners. In some questions I compared the answers of university students and of adults. I did not compare the other groups because there were not enough respondents.

The questionnaire started with general questions about the term "popularisation of science." 81.6 % of the respondents have heard the term, only 18.4 % did not hear about it. The same amount of the respondents did know what it meant. The proportion of adults and university students who knew it was almost the same. Everyone who knew the term had also come across some of the subjects of popularisation of science. They named many different subjects, for example: VIDA! science centrum, Noc vědců, Týden vědy, seminars, TV shows, Prototyp (festival), Science Slam, Technical Museum in Brno, iQLANDIA, and programs for children.

The second part of the questionnaire was about special events as Noc vědců or Týden vědy. In this case only 44.7 % of the respondents did visit some of the events (again, the proportion between university students and adults was similar) and 55.3 % did not. The reason they stated they did not visit any of these events was mainly because the date did not suite them. The main part of the people who visit these events visited them more than once (73.5 %).

The third part comprised science centres. More than a half of the respondents (59.2 %) visited some science centre in the past. From this group more than a half of them (55.6 %) visited science centre more than once, 28.9 % once, and 28.9 % visit science centre regularly. In this case, science centre is visited more by university students (75 % of them visited science centre) than by adults (51 %). The most visited parts of the science centre were the exhibitions (36 from 40 respondents) and the science shows (28 from 40 respondents). Then programs, events for families, and events for adults followed. The reason why respondents did not visit any science centre was mainly because they did not have the opportunity, or they have never heard about it. Nobody answered that it is because science centre is only for children.

The fourth part was investigating the knowledge about VIDA! After Dark events. 69.7 % of the respondents have heard about the event, only 30.3 % did not. Mostly they were university students (80 % heard about it; adults 65 %). But in contrast to these answers only 26.4 % did attend this event (73.6 % did not attend it). If they did attend it was mostly one time (64.3 %), and only a part of them visited this event more than one time (21.4 %), or they visit it regularly (14.3 %). The main reason for not attending this event was that the date did not suit them.

The fifth part was focused on summer camps or free time activities for children. These subjects of popularisation of science are not favourite – only 21.1 % of the respondents said that they or their children attended educational and popularising summer camp of free time activities. To name some of them they were activities in Technical museum or in VIDA! science centrum, astronomical free time activity at Hvězdárna Brno, and Škola matematiky a fyziky[93]. The reason for the low number, in this case, may be given by the fact that these things are becoming more offered only in recent years.

The sixth part evaluated if the respondents came across any educational and popularising show, TV show, or performance. 78.9 % responded that they did. They named for example science shows from VIDA! science centrum, BBC documents, TV Prima ZOOM, ÚDiF, programs at Hvězdárna Brno, and many TV shows (Hyde Park Civilizace. Šikulové, Brainiac, Mythbusters).

[93] School of Mathematics and Physics

Last part focused on the Hvězdárna Brno. In this case, most of the respondents visited it – 89.5 %. They visited a program, a projection, they were watching the night sky, or they attended special events there or seminars.

From this questionnaire, I found out that most of the people do know what popularisation of science is and what subjects they can visit/watch. I also found out that many people know about the subjects of popularisation of science, but never visited any of them. What I found interesting were the answers to open questions where respondents listed many types of subjects of popularisation of science they knew.

6 Educational and popularising program

In this chapter, an educational and popularising program accompanied by step by step comments is presented. The creation of the program follows the subsequent steps:

- Choosing a topic, a target age group, and defining the length of the program.
- Creating a database of experiments that might be used in the program.
- Creating the program.

This whole chapter is based on my decisions. There are no general instructions on how to create a program, it is up to the guarantor of the program who is creating it. The three points this chapter focuses on are not the only ones that are needed to complete the program. Although they are not included in this Bachelor´s thesis, after creating the program three more things should be done, namely:

- Trying whether the experiments work and the timing is right, making adjustments according to it.
- Internal presentation (presenting the program for the colleagues) and adjustment of the program according to their comments and ideas.
- First presentation for the students and adjustment to the program depending on this presentation.

These three steps can be repeated according to the needs of the creator of the program. After conducting all these steps, the program should be ready for presentation to any group of students who would like to attend it. It can be presented for example in a science centre.

6.1 Topic, target age group, length

The first step of the creation of a program is selecting a topic and a target age group. The topic should be corresponding with the School Educational Programme of the given age group. If the program follows the School Education Programme, the teacher can visit the program with their class instead of having a school lesson, because it has a connection to the information they learn. Usually it does not matter which is selected first, whether the topic or the age group. When one of these options is selected, the other one is decided accordingly. For this Bachelor´s thesis a program with experiments about electricity and

magnetism have been chosen. According to School Educational Programme for primary and lower-secondary schools by Ministerstvo školství, mládeže a tělovýchovy[94], students start to learn physics at the lower-secondary school (6th to 9th grade in the Czech Republic). As part of the physics lessons they learn the basics of electricity and magnetism. Therefore, this program will be for the lower-secondary and secondary schools. When attending this program students should remember the basics and find out that even electricity and magnetism can be interesting. The best outcome would be if the students learned something and wanted to explore more about this topic.

The program will be about 60 minutes long – a bit longer than one school lessons. In my experience it is the amount of time most students can keep attention and not get bored or distracted.

6.2 Database of experiments

This database of experiments is created with the help of YouTube. The reason for making this decision is simple – on YouTube, there are many videos with interesting experiments, but only a small amount of them is explained, usually there is only the experiment without any comment. Experiments were selected, it was described what was happening and it was explained. These explanations are for the lector, in the program they will be simplified (in case it is needed). All the following experiments were selected to be able to be carried out at home.

For the explanations of the experiments the Ampere's circuital law and Faraday's law of induction will be defined. According to Andrew McHutchon (2013) "Ampere's Law relates the integrated magnetic field around a closed loop to the electric current passing through the loop." (p. 9) It means that time-varying electric current (moving electric charge) creates a magnetic field. The Ampere's law can be also defined by the following equation:

$rot\, \boldsymbol{H} = \boldsymbol{j} + \frac{\partial \boldsymbol{D}}{\partial t}$, where

$\boldsymbol{H}$ is magnetic field strength,

$\boldsymbol{j}$ is electric current density,

[94] Ministry of Education, Youth and Sports

$\boldsymbol{D}$ is electric displacement,

and t is time.

Andrew McHutchon (2013) also wrote that Faraday's law states that "the induced electromotive force (emf) in any closed circuit is equal to the rate of change of the magnetic flux through the circuit." (p. 11) In this case, the time-varying magnetic field creates (induces) electric field. The equation for Faraday's law is following:

$rot\, \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t}$, where

$\boldsymbol{E}$ is electric field strength,

$\boldsymbol{B}$ is magnetic flux density,

and t is time.

6.2.1 Homopolar motor

Source: https://www.youtube.com/watch?v=wZho9XqXqVI

Content of the video: There is an object built from two magnets, 1.5 V battery and copper wire. One magnet is on top of the other one and it is lying on the table. On the magnets there is a battery – one of the poles of the battery is connected to the magnet. Then there is the copper wire in a special shape. The shape can be adjusted, but it must be connected to the other pole of the battery on one side and on the other side it has to reach down to the magnet, where it should touch it time to time. Once the battery with the magnets is connected to the wire, the wire starts spinning around the battery.

Explanation: Brauer, Ziolkowski, Porzig, and Toepfer (2011) described the principle of the Faraday's motor (metal wire suspended in a cup of mercury, magnet under the cup) as following: "When current from an electric battery applied to the wire, the circuit was completed via the mercury (a good conductor of electricity) and the resulting current flowing through the wire produced a magnetic field. The electromagnetic field interacted with the existing magnetic field from the permanent magnet, causing rotation of the magnet on the left, or of the wire on the right." (p. 222 – 223) In this case, the homopolar motor consists of slightly different parts, but the principle is similar. The battery is an energy source and the current flows through the wire. Current flowing through the conductor

creates magnetic field which interacts with the existing magnetic field. It completes the circuit ("connects" the wire with the other pole of the magnet) and causes rotation of the wire. The rotation is caused by Lorentz force which is according to the Encyclopaedia Britannica (n. d.) "the force exerted on a charged particle q moving with velocity $\boldsymbol{v}$ through an electric $\boldsymbol{E}$ and magnetic field $\boldsymbol{B}$."

Attached figures: In the Figure 8, there are three possible (but not limiting) shapes of the wire which can be used. Figure 9 shows the realisation of another possible shape.

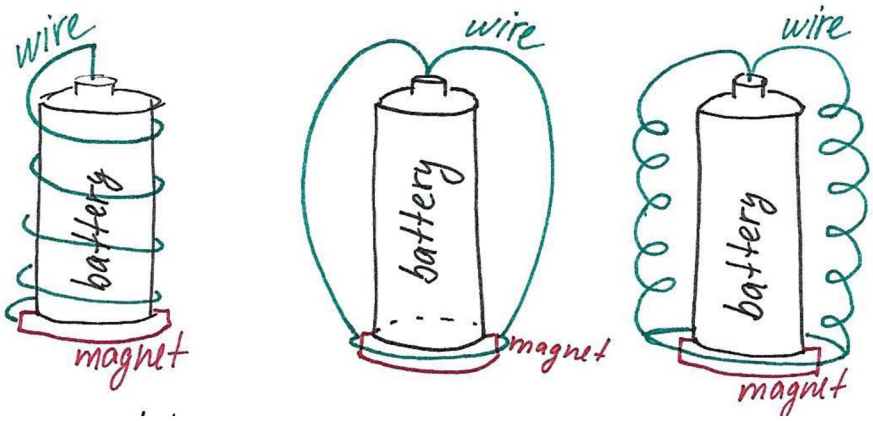


Figure 8: Homopolar motor – possible shapes of the wire

Figure 9: Realisation of homopolar motor

6.2.2 Magnetic train

Source: https://www.youtube.com/watch?v=J9b0J29OzAU

Content of the video: There is a long copper wire in a shape of a long spring (it acts as a coil), magnets, and 1.5 V battery. Magnets are attached on both poles of the battery and it is put into the coil. Once it is inside, the magnets with the battery start moving along the coil. Once it starts moving, both sides of the coil are connected so they make a circle and the magnet with the battery continues moving inside the coil in circles.

Explanation: The magnets attached to the battery must have the north poles pointing to opposite directions (if the magnet is not labelled, the location of the poles might be determined by an experiment). These two magnets create magnetic fields. Once the battery with magnets is put in the spring, the electrical circuit is connected – electrons flow from the first magnet through the spring to the second magnet. When current flows through a wire it generates a magnetic field (Faraday's law). Because of the orientation of the magnets and the magnetic field generated by the spring one side of the battery is pushed and the other one is pulled (this is the reason why the orientation of the magnets is important) which causes motion. (The Sci Guys)

Attached figures: Figure 10 shows the assembly of the experiment.

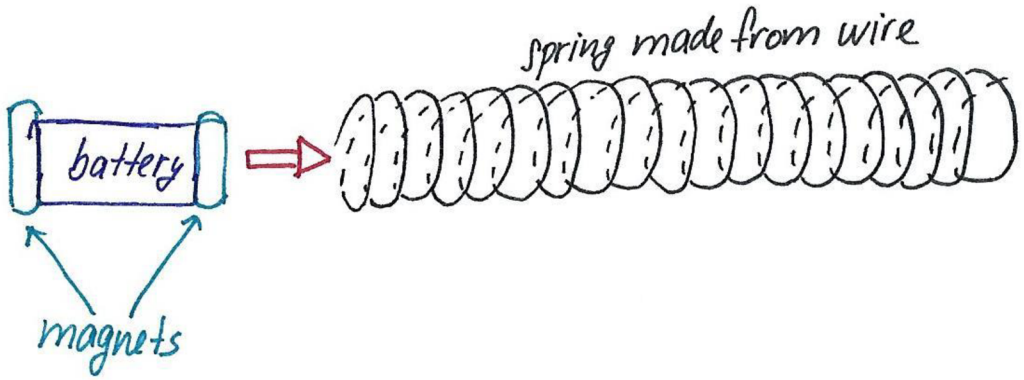


Figure 10: Magnetic train

6.2.3 Lighting up a match

Source: https://www.youtube.com/watch?v=wZho9XqXqVI

Content of the video: This experiment uses 9 V battery and graphite pencil lead to light up a match. The pencil lead is put on the 9 V battery in the way it connects both of its poles. Than the matchstick head to the pencil lead and touches it. After a few moments it is on fire.

Explanation: Graphite is a conductor. By putting it on the poles of the battery we connect them and close the electric circuit. Ohm's law defines the relationship between resistance (R), voltage (V), and current (I) as: $R = V / I$. There is only a small resistance (because graphite is a good conductor), therefore the current flowing through the pencil lead is very high and the lead starts to heat up. If we put the match on the graphite pencil lead, it will light up because of the heat from the graphite.

Attached figures: Figure 11 shows the way how to conduct this experiment.

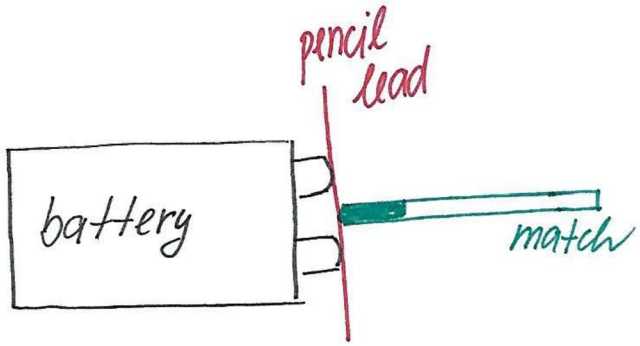


Figure 11: Lighting up a match

6.2.4 Visualisation of the magnetic field

Source: https://www.youtube.com/watch?v=-MDlKnpHS-M

Content of the video: There is more than one way of showing the magnetic field. First, there is a homemade coil (it is made from a carton and a copper wire – the wire is going through the carton and it forms a coil; the carton goes right through the middle of the coil) connected to a power supply and iron sawdust is sprinkled on it. Second, the paper is put on a long magnet and the iron sawdust is sprinkled on it. In both cases, the lines of the force are shown.

Explanation: Magnetic field can be visualised with the help of the magnetic field lines. According to Halliday, Resnick, and Walker (2011) “the lines all pass through the magnet,

and they all form closed loops. The external magnetic effects of a bar magnet are strongest near its ends, where the field lines are most closely spaced. The (closed) field lines enter one end of a magnet and exit the other end. The end of a magnet from which the field lines emerge is called the north pole of the magnet; the other end, where field lines enter the magnet, is called the south pole. Because a magnet has two poles, it is said to be a magnetic dipole." (p. 738) In this case we are using the fact that iron sawdust is ferromagnetic (it attracts to the magnet and the magnetic field might partially persist when the magnet is moved away). The field around the coil connected to the power supply also has a magnetic field because of the Ampere's law.

Attached figures: In the Figure 12 there is a bar magnet and its magnetic field lines which represent the magnetic field. The result of this experiment conducted with a magnet dipole can be seen in the Figure13.

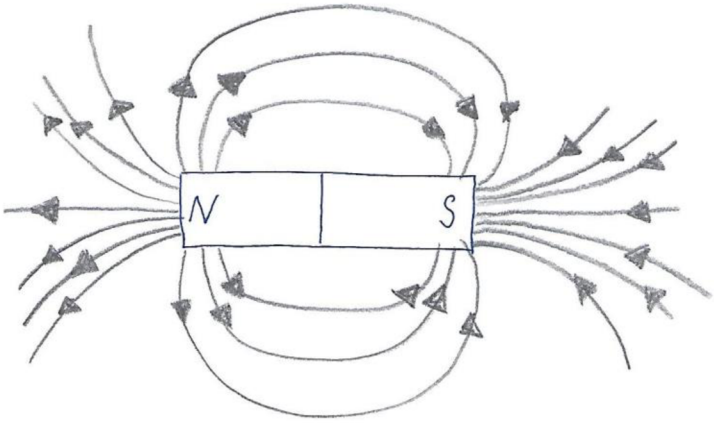


Figure 12: Magnetic field lines of a magnetic dipole

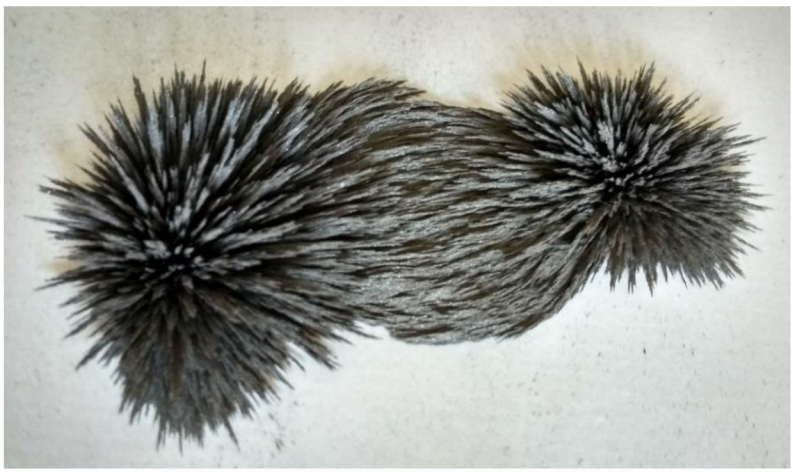


Figure 13: Magnetic field lined of a magnetic dipole depicted with help of the iron sawdust

6.2.5 Electromagnet

Source: https://www.youtube.com/watch?v=PwVuLK0Q-po

Content of the video: A copper wire is winded around a screw – to make a simple coil. On both sides, the wire is connected to a 1.5 V battery by being taped on one of its poles. Once it is connected it attracts metal objects – in this case paper clips.

Explanation: Once the wire is connected to the battery currents starts to flow through it and generates a magnetic field (Ampere's law). When the magnetic field arises, the screw with the copper wire can attract metal objects.

Attached figures: The assembly is illustrated in the Figure 14.

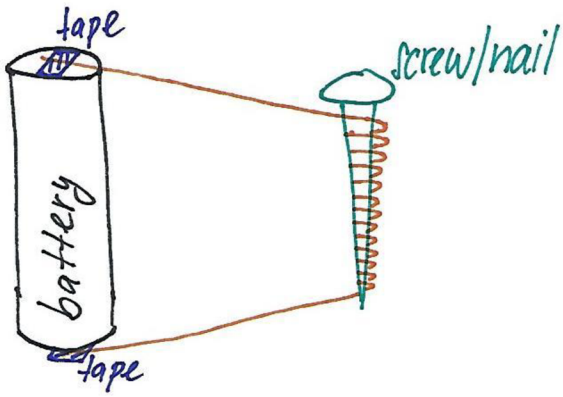


Figure 14: Homemade electromagnet

6.2.6 Homemade DC motor

Source: https://www.youtube.com/watch?v=-MDlKnpHS-M&t=162s

Content of the video: There is a demonstration of the work of a simple DC motor, which can be built at home. It is made from a cup that stands bottom up and has a magnet on the top. On the bottom of the cup, there is also a small stand (electrically conductive) and it has a coil made from a wire on the top. The coil is connected to a 1.5 V battery. Once the coil gets a little push it starts spinning.

Explanation: The aim of a DC motor is to convert electrical energy into mechanical energy. When the coil of this simplified DC motor is connected to the battery the current

starts flowing through it. According to the Ampere's law – current is flowing through the coil and magnetic field is generated. The magnetic field of the coil interacts with the magnetic field of the magnet and once the coil gets a little push it starts spinning (Lorentz force).

Attached figures: The assembly is shown in the Figure 15.

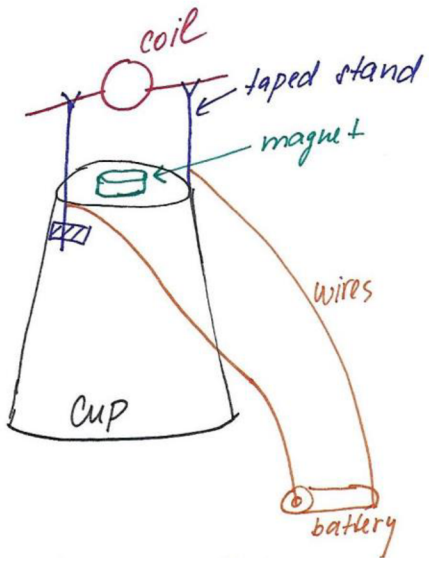


Figure 15: Homemade DC motor

6.3 Program

Material to be prepared in advance the program:

- On the tables for students:
  - Box 1: magnet (dipole), plastic plate, iron sawdust.
  - Gloves for each of the students.
- On the table of the lector:
  - Pictures of homopolar motor, DC motor, electromagnet, and magnetic field lines of a dipole.
- On a side table (material to be distributed during the program):
  - Box 2: 1.5 V battery, tape, screw/nail, copper wire, box of paper clips.
  - Box 3: magnet, 1.5 V battery, copper spring, copper wire, pincers.
  - Box 4: magnet, cup, metal pieces, wire, coil, tape.
  - Box 5: 9 V battery, graphite pencil lead, match.

When everything is prepared the program can start. The following text is a guideline for the lector:

"Hello, my name is Martina and today we will spend about 60 minutes together on a program. Do you know what program you came for? *(Ideally, they know and say it.)* Yes, it is a program about electricity and magnetism. Today we will find out something more about these phenomena. Please, listen to the instruction I give you during the program and do not work ahead, because then the experiments might not work out. I will guide you through all the experiments and in case it is more difficult construction, I will show a picture to help you. Please, once we connect any wires to the power supply make sure you will not touch anything conductive – wires, metal, etc. To ensure your safety each of you will get gloves – please wear them when conducting experiments.

Experiment 1 – Visualisation of the magnetic field. Okay, let's start with a simple experiment. Let's see how the lines of force of the magnet look like. Please take a magnet and a plastic plate. Cover the plate with iron sawdust. Now put the magnet under the plate and see what it does. You can try spinning the magnet, moving it, taking it away and back, and much more. Just please do not put the magnet in the iron sawdust, because it would get stuck on it. *Time for conducting the experiment*. Do you know what happened here? With the help of the iron sawdust we have visualised the magnetic field of the magnet. As you can see in the picture *(showing picture of magnetic field lines)*, we illustrate the magnetic field with the help of magnetic field lines. These lines go from north pole to the south pole of the magnetic dipole and the magnetic field is strongest at the ends of the magnet where the magnetic field lines are closer to each other. And I am sure you know why we used the iron sawdust – it is because it is ferromagnetic, therefore it attracts to the magnet.

Now let's see why this program is not only about magnetism, but also about electricity. The reason is simple - these two phenomena are interconnected. Did you learn about the Ampere's and Faraday's law? These laws are also known as the laws of electromagnetism. *They might have heard about it, but maybe not in this context. Maybe someone will know what it is and describe it. It does not matter if they did not know about it, at least they will learn something new.* The Ampere's law tells us that moving electric

charge (current) creates magnetic field and the Faraday's law states that varying magnetic field induces (creates) electric field.

Distribution of box 2.

Experiment 2 – Electromagnet. You know the theoretical part of this phenomena. But we are here to test it, to try it. First, we will look at the Ampere's law. Take a nail and round it with copper wire as you can see in this picture *(showing picture of electromagnet).* Then tape the ends of the wire to the poles of the magnet. Now the current is flowing, and you can try to put the screw close to the paper clips. Be careful not to touch the battery, it will get hot, hold it on the taped part. *Time for conducting the experiment.* Doing this experiment, we have verified the Ampere's law – when we connected the wire to the battery the moving charge created magnetic field and the magnetic field attracted the paper clips.

Distribution of box 3.

Experiment 3 – Magnetic train. Now take magnets, battery and the long spring. What you will do is simple. You put one magnet on both poles of the battery – note that the poles of the magnet are labelled, you must connect the magnets to the battery in a way that its north poles will be pointing in opposite directions. Now put the battery inside the spring, give it a little push and connect the two endings of the spring so it forms a circle. Go ahead, let´s see what happens. *Time for conducting the experiment.* When you put the battery with the magnets inside the spring you connected the circuit and the current could start flowing. According to the Faraday's law once the current is flowing it generates magnetic field. Because of the orientation of the magnets and the magnetic field generated by the spring one side of the battery is pushed and the other one is pulled which results in the motion.

Experiment 4 – Homopolar motor. Now you have seen what battery with a magnet can do. I have one more similar experiment for you, but in this case, you will have to prepare it by yourselves. This time, we will use the battery with the magnet connected to one of its poles. In the box you also have a copper wire and pincers. Your task is to make a construction from the wire which will be connected to the second pole of the battery and will reach to the magnet, where it will touch it time to time. How will the construction look like is up to you, but here are some examples *(showing picture of homopolar motor).* When you have the construction, put it on the battery and give it a little push for it to start a rotation. *Time for conducting the experiment.* This experiment is a bit more complex.

The battery is an energy source and the current flows through the wire where it creates a magnetic field. The magnetic field of the wires interacts with the existing magnetic field of the magnet, it completes the circuit and also causes rotation of the wire.

Distribution of box 4.

Experiment 5 – Homemade DC motor. We will stick to the induction and build a small DC motor. All you need is in the box I gave you. You take a cup and put it on the table – bottom up. You put a magnet on the top of the cup. Now take the metal pieces and with help of a tape attach them to the cup with the open ends at the top – you will make a stand for the coil. Take the coil and put it on it. The last thing to do is to connect the stand to the battery and again, give the coil a little push. In case you need help, here is a picture of your target structure *(showing picture of DC motor). Time for conducting the experiment.* When you connected the coil with help of the wire to the battery the current started flowing through it and again, as the Faraday's law states, it created magnetic field. This magnetic field interacted with the magnetic field of the magnet and once the coil gets a little push it starts spinning.

Distribution of box 5.

Experiment 6 – Lighting up a match. Now let's see the electric side of electromagnetism. We will light a match with the help of electricity. Take a 9 V battery and a graphite pencil lead. Put it on the top of the battery in a way it connects both its poles. After that, take a match and put its head on the graphite. Please be careful. *Time for conducting the experiment.* This is a simple experiment where we use the electric conductivity of the graphite. The graphite connects both poles of the battery, the current starts heating it up and we used the heat to light the match.

That was the last experiment I prepared for you. But before you go, let´s go again through all we have done today. *Talking about individual experiments and its principles (students should be the ones who tells how it works – short simple explanation is enough).* Okay, that is it. Great work. That will be all from me. I hope you liked this program. Have a nice day! Bye."

6.3.1 Important notes

In this subchapter experiments from the database (subchapter 6.2) were selected and compiled into an educational and popularising program. In a program, there cannot be only experiments and their explanations. It would not be interesting, and the audience would lose attention. It is necessary to make it interesting and make some connections between the experiments – if possible, it is ideal to have some simple storyline which is appropriate for the given age group. If the students are older (as in this case) it should be enough if the experiments have a logical connection.

It is important to engage the audience and give them enough time to try everything by themselves. If it takes them too much time it is better to skip some experiment than to rush them.

It is also important to note that the program was created according to the experiments found on YouTube and that additional changes in the process might have to be done due to the fact that the experiments might not work in the way how it was described.

7 Conclusion

This Bachelor´s thesis is focused on the popularisation of science in the Czech Republic. A review of the literature available (books and websites stated in the references) has been carried out. First, the term "popularisation of science" was defined. It is a way of presenting scientific knowledge to the public in an interesting and comprehensive way. Also, research about subjects of popularisation of science was done. In this Bachelor´s thesis, the focus has been mainly on the concept of science centres. There are many more subjects, but their analysis was only partial. Doing this research, I found out that many of the science centres have their websites only in Czech language and not available also in English language or only partly in English language – in my opinion, this is a huge deficiency. In the thesis Czech terms were used and then translated. Most of the web sites stated English versions of the terms, but sometimes they had to be translated for the present thesis.

All the subjects mentioned in my thesis focus on something different and they use different methods of targeting the audience. In general, science centres target everyone, but their individual events are aimed at particular age groups. The program is adapted for the given audience. Moreover, there are for example videos on YouTube by Zvědátoři which target children/teenagers who are interested in "youtubers" and watch their videos.

A questionnaire about the possibilities of popularisation of science in Brno was conducted. I received only a limited number of questions, therefore the results do not apply for the whole public. Nevertheless, it gives us an overall idea about how well people living in Brno are informed. In this research, I discovered interesting information about the respondents. What is interesting and important for this Bachelor´s thesis is the fact that there are many subjects popularising science. However, although the respondents often know about the subjects, they do not visit them.

I would like to note that all the information regarding the subjects might change in time, because this is a field which is evolving and changing very quickly, and that information was up to date in December 2018.

A popularising and educational program for the lower-secondary and secondary schools focused on electricity and magnetism was prepared. The program was created with

the help of YouTube – the experiments were taken from the videos from this website, explained, and compiled into a program.

In the future, further research about other subjects to extend this thesis could be done. Regarding the program, there are further steps which must be done before the program can be used. First, the experiments should be carried out, it should be proved that they work, and they should be well rehearsed. The program should be practised to see if the timing is right. Then an internal presentation of this program follows and if successful, the program is ready for the first presentation for schools. During all these steps additional changes regarding the experiments or timing can be done. These steps will be conducted during summer and autumn 2019. After conducting all these steps, the program will be ready for presentation in a science centre or in a private subject.

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9 List of tables

10 List of graphs

11 List of figures