Entertainment-education in science education

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the monograph edited by

Grzegorz Karwasz & Małgorzata Nodzyńska

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The monograph edited by:
prof. dr hab. inż. Grzegorz Karwasz
dr hab. Małgorzata Nodzyńska

Reviewers:
dr hab. Dorota Siemieniecka, prof. UMK
prof. dr hab. Mariusz Gagoś, UMCS

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Ewelina Kobylańska

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Multimedia in science education

Introduction

Nowadays, there is no effective education without new technologies. The introduction of new media on a wide scale to the education is a must, which is also enforced by the technological development and globalization. You cannot longer effectively teach young people accustomed to the digital world (that is, by Mark Prensky - „digital natives") by means of conventional methods of teaching. Young people who are brought up using audiovisual media, who are accustomed to writing e-mails and SMS, show no interest in a traditional book, solving difficult tasks, collecting statistical data. Students choose unlimited surfing on the Internet, which they believe is „a treasure trove of knowledge". They spend their time surfing the net, watching YouTube video, Tweeting or posting on social media and instant messaging. Instead of devoting their time on studying sciences, they spend many hours on surfing the net without even being aware of the time flow.

A characteristic feature of modern educational systems is the search for more and more attractive and more efficient methods and forms of work with the student. This feature applies to all stages and levels of education. The use of computers in teaching can reduce the students' formation process of thinking. Too easy an access to knowledge prevents them from thinking independently, and hence they does not develop enough deductive thinking. Therefore it is important that we use in the teaching process various available teaching aids, which especially are complementary and comprehensively develop learners skills. An attractive aspect of teaching - learning science is presented in an interactive way. Forget about the fact that the teaching should be close to what the student knows from daily life and from the media. Science is the knowledge of the world and should not be limited only to describing experiments at the school laboratory, it must definitely go beyond the school building.

According to the theory of multimedia learning by Richard Mayer the information received by us is processed separately in two channels: the visual one and the audible one. The first is responsible for what we see (pictures, graphics, videos, graphs) and the other for what we hear (sound, comments). A person can receive and process signals that come to him from two independent sources at the same time (Mayer, 2009). Appropriate action in multimedia education is the awakening of activity and cognitive processes through a prepared or selected educational materials, including Internet sources (Skibińska, Kwiatkowska & Majewska, 2014). Work in a network of active search, and not just passive viewing pages, supports the mental processes. This is due to the development of students' skills in critical and analytical thinking (Tapscott, 2010). Multimedia

presentations, videos and quizzes are the resources stimulating students' activity and interactions in the emotional and motivation sphere. High efficiency of teaching can be achieved by mastering a few basic skills, which include: searching, collecting, selecting, comparing and analyzing the information. Well developed multimedia materials not only enliven and add variety to the learning process, but also make it easier to understand and remember the content posted. Particular attention should be paid to the aesthetics of the site or a program and applied the colors. Several studies indicate that too many colors makes it difficult to read the message, and also understand the message (Lindsay, 1991). Tasks requiring the use of reflection and the ability to formulate meaningful questions and answers provides a lot of good results in the science education. Educational materials should be adapted to an appropriate level of teaching and the preferred learning style and the overall learning process. Educational portals provoke to people of all ages to cognitive activity and self-learning.

Methods

Research questions

Dr. A. Kamińska has prepared a questionnaire and conducted a study in 2010 on a group of about 150 secondary school students. The results obtained show that they have worked with the computer on average four hours per day (outside the school), including they surfing the net approximately 3.5 hours. The surveys were carried out again in 2016 on a group of students from the same schools. It has been observed that the students spend less time in front of the computer, on average 1.7 hours per day. However, they spend more time surfing the Internet much more time - about 7 hours daily. It turned out that students do not use so often computers, but they prefer variety of different smartphones and tablets. They only devote 45 minutes a day using the media for learning. Being asked the question: „what purpose do you use the computer for?", we received the following answers from the students: for entertainment and games (76 %), for social media (60 %), for learning (32 %), for listening to (or download) music (15 %) (Fig. 1).

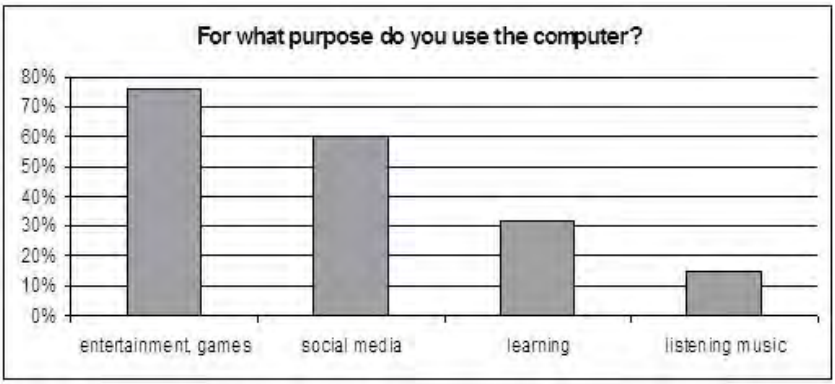

Figure 1. The results of a questionnaire conducted in the school year 2015/16 among secondary school students

Among the answers to the question of what multimedia programs you use - 80% of the interviewees do not know any educational programs, the others responded in the following way: Wikipedia (10%) and there were some single responses which included: Wirtualna Polska, Google, bryk.pl, sciaga.pl.

The question of how computer programs can help in learning, the students responded that you can find ready solution of the tasks, essays, etc. (as much as 90% of the respondents). Therefore, to provide a positive educational outcome of the use of mass media, care should be taken to properly guide its application. Teachers and educators should, on one hand, conduct properly thought-out and planned media education and, on the other hand, point to the dangers associated with it. We should not be afraid of new technologies. Instead we should use them as a modern resource to achieve our goals. The use of new technologies along with the increasing level of education will change the attitude to science. Its reception will be more active, thoughtful and focused on choosing the right content. The same survey of high school students shows that they are aware of the benefits offered by the new technologies. The question of how computer educational programs help them in their learning process, the high school students surveyed replied that they help them consolidate the part of the material previously discussed in the class (animations, tests, written reports), develop independent thinking, memorize quicker, deduct some processes, stimulate the aesthetics note keeping, teach precision and accuracy in the transfer of information, prepare charts and drawings, find certain information quicker, shape simple and communicative scientific language, adjust working time student to their own capabilities and enable them to acquire knowledge and facilitate the development of an individual learning without any stress. Despite the threats modern technologies give us unlimited possibilities of making science education more attractive. Speaking about the usefulness of new technologies in the educational process one should

be aware that they should meet certain requirements: be innovative, interactive, intuitive and have the ability to fit the individual needs of the user (Okoniewska & Meger, 2002).

Multimedia education is a broader concept which involves the use of the teaching process, a variety of teaching methods and different, specially selected materials, such as films, recordings, computer programs, as well as the traditional scientific aids. Sound effects, which hugely enrich the way of teaching, are often applied in media literacy. They should be designed and introduced into the process of teaching and learning in the form of a multimedia package, providing the learning information through different channels of communication. This way of transmitting information to start multiple types of students' activity, for example: perceptual, manual, intellectual and emotional (Strykowski, 1984).

E – books

Teachers, parents and students alone recognize the e-books possibilities that they offer the positive impact on the development and progress of students in science education. The results of a on-line survey, which was carried out by the Polish Ministry of National Education (MEN) in October and November 2012, confirms the need to introduce information and communication technologies in schools. In the survey 10 229 people responded, including 5716 teachers, 1373 parents and 3140 students and other participants. Most teachers believe that e-books will help to develop the skills of creative use of available sources of knowledge, will affect the development of creativity and will help to develop students' skills. In their opinion, the biggest advantage of e-books will be interactive exercises because it will help consolidate the material and videos and educational games (about 90%). Teachers appreciate the possibility to carry out interactive simulation experiments, using the self-checking test or filling digital workbook. They hope also to track students' progress and the ability to modify any learning content. According to parents, these elements they will would encourage their children to learn. On the basis of research results obtained by MEN up to 73% of students acknowledge that they spend more than 10 hours per week in front of the computer. Among the people surveyed 95% search for a variety of information, but the same number of people use it to maintain social contacts, or for the entertainment. Only 23 percent of respondents think that e-books will contribute to the creative use of available sources of knowledge and creative thinking. They also recognize the possibility of equalizing educational opportunities for children, to increase their participation in culture elements, development of skills in different subjects, skills development cooperation (MEN, 2013).

Research conducted by the Organization Project Tomorrow in 2009 among American students, shows that young people expects that school, above all will have greater access to mobile tools. The researchers gathered the students' ideas on how to create the perfect digital textbook. For many of them, the prospect of

using the paper guide is repulsive and archaic. Young people would like to have the ability to match the form of a manual to their individual needs, for example through the application of underscores, or adding notes. They would like to have the assistance of a specialist in the field that could answer their questions online, also after the end of the school. Both students and parents highly appreciate a career in areas such as science and life sciences. More than half of parents just to learn these areas encourages its children the most (Andrzejczak, 2009).

As the first on the Polish market appeared manuals EduROM Publishing Young Digital Poland (Ed. 2001). These included the whole package present multimedia textbooks for secondary school (Polish language, mathematics, physics, geography, biology, history, chemistry). Today, almost every textbook publisher includes a CD into the book set. Multimedia textbooks can be used by the teacher during the lesson to illustrate the experience simulation, explaining the essence of the phenomenon. It is on important functions of this type of a textbooks to enable its use at home. The student has the opportunity to carefully analyze the course of an experiment conducted in the classroom during a lesson once again, with a detailed description of the phenomenon and deepen their knowledge about the content that was not discussed on the lessons.

Multimedia textbooks to teach biology, chemistry and physics include lectures, photos, 3D animations, videos, and interactive exercises. Educational content is illustrated with numerous videos and 3D presentations that facilitate the understanding of particular issues. Videos and multimedia presentations allow you to remind students that physical phenomena occur not only in the classroom or laboratory, but in the whole world around us. Thanks to the movies and animations you can present a physical experience which is impossible to do in the classroom, for example: because of security precautions, because it requires too expensive equipment or inaccessible devices. In order to consolidate the new material, it is included in CD exercises checking that students can solve them systematic. These tests check the level of understanding of the material and allow you to prepare for tests and exams.

Due to the increasing sales of tablets along with the teachers', parents' and students' growing interest and expectations towards new teaching methods, new educational programs for mobile devices have been introduced. (Fig. 2). Mobile chemistry is a textbook created by the staff of the Adam Mickiewicz University in Poznań which is primarily dedicated to teach chemistry. It is compatible with the operating systems of Android, iOS and Windows. This is not the electronic version of printed materials, enriched only a few illustrations of enlarging the film (as a number of programs to support teaching available on the Web), but creates new opportunities for student interaction in the process of teaching - learning. It deserve special attention because it includes (Bartoszewicz & Gulińska, 2015):

- videos with tasks, animation, radio broadcast,
- rich selection of well illustrated experiments,

- proposals of different experiences that can be taken at home,
- educational games, virtual laboratory, project proposals,
- interactive task for the student.

Figure 2. Mobil chemistry to support entertainment-education in science education available on mobile devices

Interactive tasks allow you to quickly verify the acquired knowledge. However, instead of filling in the gaps, or combining the elements of drawing with pencil lines, simply drag items using your hand or stylus. This is fun learning chemistry, if you make a mistake, you can easily improve your figure.

Laboratory of Multimedia in Education and Culture

In order to achieve the effective teaching of science with the use of multimedia resources we organized in 2015 new laboratory of Multimedia in Education and Culture in the Institute of Physics at Nicolaus Copernicus University in Toruń. During the classes we observed a huge interest of students in this form of acquiring knowledge (Fig. 3). First of all, students can compare not only different contents, but also various attitudes towards presenting it – in a manner more or less effective, respecting the cognitive teaching methods. The ability to assess the suitability of available multimedia resources and their use in science education is an important competence of future teachers. The main advantage of the multimedia encyclopedia installed on computers in our new laboratory is that they are closed resource (CD-Roms on Science, Education and Culture), thus enabling students to concentrate on learning focused on a specific subject and activity which allows to go back to try and check again. Nowadays, most children and students use the Internet every day and have to deal with hyperinflation occurring here information (Karwasz, 2012). There is the problem of how to find the best information among the thousands of pages found by the search engine.

Figure 3. Students in the classroom learning in a friendly atmosphere conducive to acquiring new knowledge and skills

The important role of multimedia in science education was proposed already in the 90s of the twentieth century. Regular multimedia textbooks at high school level were already present on the Italian market and a publishing house of Dorling Kindersley published a thematic encyclopedias to teach Science subjects such as: Earth, Birds, Human Body, Animal Encyclopedia and others. At the time, educational software used in the classroom with students and pupils mainly came from abroad. In the late 90's of the twentieth century, the first multimedia encyclopedia has been published by Polish publishers and became available on the market. The first interactive exhibition of multimedia educational software was organized by us at Pomeranian Academy in Słupsk as early as in 1997. Later, with the advent of the Internet, the development of new multimedia declined.

In the present paper we discuss the variety of available multimedia resources in science education, respecting the division proposed some time ago (Karwasz, 2010): the collection of loose files, educational pathways, encyclopedia, multimedia textbooks. Among the multimedia, there are resources of communication with users: photos, pictures, diagrams, movies, animation, 3D animation, narratives, music, sounds.

In the process of teaching science the multimedia textbooks are very useful, where we meet the two essential requirements (Okoniewska & Meger, 2002):

• multimedia and interactivity - the appropriate use diagrams, animations, movies. A correct animation is the one that can be run step by step, to see its details. The film should be different from a traditional television programme even in the way that one can stop it at any point and view frame by frame in order to explain the phenomenon presented.

• multi-level structure - is a fundamental difference between the traditional textbook and computer presentation program. In case of a computer program, the teaching/learning content is properly ordered and planned either by the teacher or the student. Multimedia textbooks do organize knowledge on several levels, according to its importance and learner's predispositions.

The value in using of the program determines the external form of software, its functionality, and concluded its substantive content. Computer learning programs cannot be a simple reflection the content of a printed textbook. These programs should make full use of the technical capabilities of a computer. Educational programs need to have an attractive form, which enables colorful animations and sound. It is very important that these programs are characterized by a substantial correctness and teaching content must be consistent with the current state of science (Morbitzer, 1997). The content must also be adapted to the curriculum for the type and level of education in such a way that the program can be used in a teaching process at the right time. A very important feature of a good educational program is simplicity, which is a well-designed user interface, which allows the student to well concentrate on the substantive content provided by the program and facilitate the support for the program. The corresponding interface is usually the determining factor in the assessment of the whole program. A major role here is the language of communication with the computer, and the interface (the arrangement of the information on the screen), the system of evaluation and reward, the response and reaction of the computer on incorrect data. Computer programs should be tailored to the individual user's work rate. A special form of individualization of content is the ability to repeat selected parts of the program so that the learner can always go back to them many times. Such a feature of the educational program provides the structure and use of appropriate control mechanisms.

To the active and creative teaching physics developed educational pathways „Physics and Toys", where playing objects becomes a pretext to get interested in Science (Karwasz, 2005). The multimedia resource created at Pomeranian Academy in Słupsk in 2003-2005 had on the website of Didactics of Physics Division at Nicolaus Copernicus University in Toruń more than 200 000 views in six years, and exercised a strong influence on development of interactive Physics in Poland (Fig. 4).

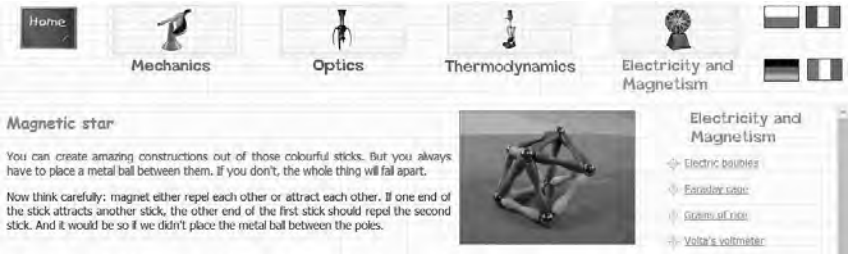

Figure 4. "Physics and Toys" educational pathways. On the screen you can find photos, videos, a brief description of the experiment and the 1.5 bit of new information for the user

In the four branches of Physics here are descriptions and videos of about 100 interesting experiments and they are available in five languages (English, French, German, Italian, Polish). The descriptions are short (5-6 sentences) to encourage the student to read carefully and take an interest in the presented experiment. The end of the description is humorous and funny in order to get a positive reception. At the end of the text here is a link more and when interested people click it and they can get a detailed description of the experiment and of the phenomenon (Fig. 5). In this part of the detailed description of the experiment there are diagrams, formulas, new scientific concepts to detailed explanation of this phenomenon. The Internet has become the main source of knowledge for the younger generation. Information technology is changing the world and our students. Teachers should improve their skills and teaching methods and offer students a wise use of Internet resources. The way of describing the experience should be very friendly for students. A short description of the causes that students can easily remember is on important piece of information and new concepts. This way of describing the experience is very effective and makes the teaching of physics and science more exciting and attractive for students.

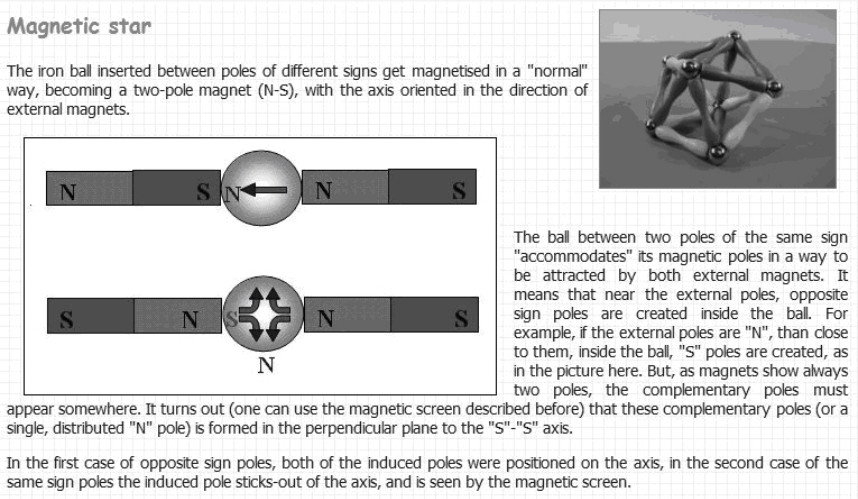

Figure 5. The detailed description with explanation of the experiment entitled "magnetic star"

„The Ultimate Human Body" published by Optimus Pascal and Dorling Kindersley Multimedia is an example of a well-prepared and developed multimedia encyclopedia in science education (Fig. 6).

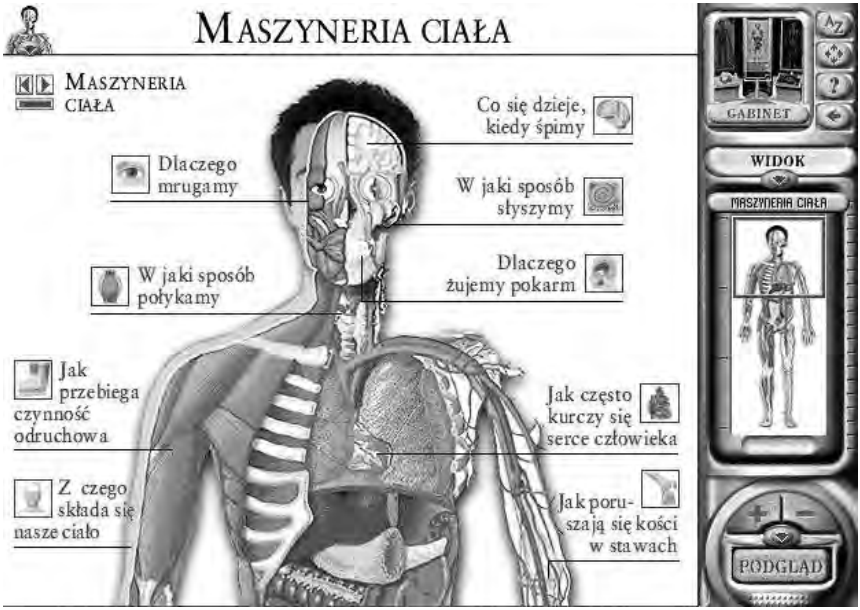

Figure 6. An example of the screen the multimedia encyclopedia with an intuitive menu and extremely interesting content on the internal structure of the human body

This is a wonderful journey into the interior of the human body illustrated with many photographs, colorful drawings, videos and texts that can be read aloud. The contents of the material is extremely interesting, focusing our attention and stimulating to discuss the issues and encouraging the learning of science in a fun way. The encyclopedia can be used during lessons at school at various levels of teaching and student can also use it at home, if they would like to know more about the structure of the human body. The CD contains extremely useful information on the functioning of our body and its various organs and systems such as circulatory system, nervous system and bones. The concept of pedagogical, social phenomenon, interpersonal relationships, experience personal take on new meaning and for the author, and the recipient if you give them the form of photos, drawings, metamorphosis, video or audio. Student is a unique experience to enrich not only their own workshop, but above all personality (Siemieniecki, 2001).

In the science education for the young the multimedia encyclopedia entitled „Cell Biology" published by Polish Editors Prószyński and Company seems to be very valuable (Fig. 7).

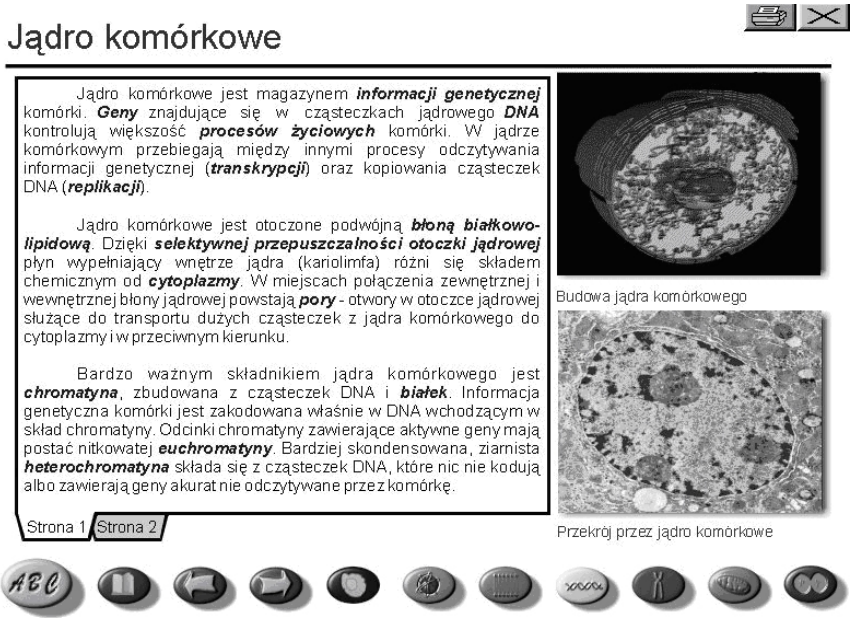

Figure 7. Description of the nucleus with photos and a cross-section of the cell nucleus

The encyclopedia contains a lot of interesting pictures (also in high magnification), videos, descriptions with links that provide easy access to the next message. On the CD, you can see the ordered structure of knowledge and concepts. This makes it easier to learn and acquire new skills in the field of science education. Another very interesting encyclopedia among the collections of the new laboratory is the encyclopedia Earth published by Polish Scientific Editors (Fig. 8).

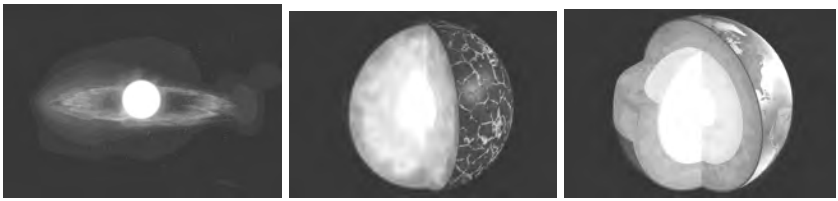

Figure 8. Sample photos from Earth encyclopedia: a) a picture of the formation of the Sun and our solar system, b) photo illustrating the formation of the Earth in the start-up period, when it was formed the nucleus, c) the Earth with oceans and continents on the surface

The encyclopedia entitled „Earth" is a rich source of knowledge about our

planet. The multimedia layer is enriched with a number of popular science films and fascinating animation. They are very attractive for the user, in comparison with the traditional printed book, as they provide a detailed construction, of the growth and functioning of the Earth. While watching movies and animations the teacher explains phenomena presented among other things, the formation and the formation of the Earth. Themes are developed in a clear, comprehensive and interdisciplinary, and the contents of the CD is a proven factually by many authors. The bibliographic sources put forth knowledge are up to date and come from the Polish Scientific Editor.

In order to teach science effectively, interdisciplinarily and in modern way we created a website „Fizyka dla każdego" (Physics for Everyone) (http://dydaktyka.fizyka.umk.pl) in the Didactics of Physics Division at Nicolaus Copernicus University in Toruń. You can find on-line multimedia on our website, such as: video recordings of lectures and lessons, short movies with experiments, animations and simulations of different phenomena, interesting photos and diagrams, descriptions of experiments, press reviews, tweets, educational funny materials for pupils, students and teachers (Fig. 9).

Figure 9. Various ways of directing the user's attention to important content on the "Physics for Everyone"

Every day we observe from 500 to 1000 different users surfing our website. Most often users use the pages on which there are videos and descriptions of

funny cheap and simple experiments. Videos implements the various learning objectives, as part of a triad of „cognitive" of G. Karwasz (Karwasz & Kruk, 2012): i) interest and fun, 2) understanding and explanation, 3) exploration and independent reasoning. A good example of such a material is film "Ball, jump up!" (Fig. 9). This is a movie about a falling ball, but played backwards. Multimedia and Internet have a very large impact on learning and a better use of time in the classroom. It is changing the role of the student in the classroom. In the constructivist classroom, students often work together, they have more opportunities to make choices and play a more active role in their own learning process (Pitler, Hubbell & Kuhn, 2015)

Conclusions

Multimedia play a very important role in science education. Students do not imagine a lesson without them, and more and more often they ask teachers about the use of multimedia in the classroom. This attractive and a little entertainment-education corresponds to the students, because they are more active, interested and process the messages and skills in a better way. Additionally, multimedia in science education allow us: to make our learning process more attractive, consolidate the knowledge, focus students on a knowledge transfer, illustrate the phenomenon hard to imagine and impossible to carry out, increase the effectiveness of teaching science, stimulate cognitive activity and creativity.

References

Andrzejczak, A. (2009). Czego pragną uczniowie. In *Edunews*, http://www.edunews.pl/badania-i-debaty/badania/682-czego-pragna-uczniowie - 14.08.2016

Bartoszewicz, M. & Gulińska, H. (2015). Rola mobilnych technologii w nauczaniu chemii, In *Edukacja a Nowe Technologie w kulturze, informacji, komunikacji,* Wydawnictwo Naukowe UMK Toruń.

Karwasz, G. (2012). Hyper-constructivism as an answer on the hyper-inflation of information (in Polish), In *Media Education in the Post-modern World*, ed. B. Siemieniecki, Sci. Editors UMK, Toruń, 365-386.

http://dydaktyka.fizyka.umk.pl/Pliki/Media_2012_GK.pdf - 14.08.2016

Karwasz G, Kruk J. (2012), *Idee i realizacje dydaktyki interaktywnej.* Wyd. Naukowe UMK, 26.

Karwasz G. (2010). Are media needed in didactics? (in Polish) In *Media in Education, Culture and Social Change – Cognitive Aspects*, ed. S .Juszczyk, Adam Marszałek Editions, Toruń, 167-172, http://dydaktyka.fizyka.umk.pl/Pliki/Czy_media_w_dydaktyce_sa_potrzebne.pdf - 14.08.2016

Karwasz G., Wróblewski T., Kamińska A. & Rajch E. (2005). *Toys and Physics*,

CD-Rom, Soliton Musics and Education, Sopot, http://dydaktyka.fizyka.umk.pl/zabawki1/ - 14.08.2016

Lindsay, P. H. & Norman, D. A. (1991). *Procesy przetwarzania informacji u człowieka. Wprowadzenie do psychologii*. PWN Warszawa.

Mayer, R. E. (2009). Multimedia Learning. Cambridge University Press., In *Cognitive Theory of Multimedia Learning* (Mayer)

http://www.learning-theories.com/cognitive-theory-of-multimedia-learning-mayer.html - 14.08.2016

Ministerstwo Edukacji Narodowej (2013). *E-podręczniki i „Cyfrowa szkoła" - wyniki ankiety,* https://archiwum.men.gov.pl/index.php?option=com_content&view=article&id=3971%3Ae-podrczniki-i-cyfrowa-szkoaq-wyniki-ankiety&catid=97%3Aksztacenie-i-kadra-edukacja-informatyczna-i-medialna-default&Itemid=134 - 14.08.2016

Morbitzer, J. (Ed.) (1997). *Współczesna technologia kształcenia, wybrane zagadnienia*, Wydawnictwo Naukowe WSP, Kraków.

Okoniewska, A. & Meger, A. (2002). Multimedia tools in teaching Physics, (in Polish), In *Fizyka w Szkole*, nr 1/2002, 30-36, www.wsip.com.pl/serwisy/czasfiz/strony/meger.htm - on 14.08.2016

Pitler, H., Hubbell, E. R. & Kuhn, M. (2015). *Efektywne wykorzystanie nowych technologii na lekcjach*, Ośrodek Rozwoju Edukacji, Warszawa.

Siemieniecki, B. (2001). Kierunki zmian we współczesnej edukacji a technologia informacyjno - komunikacyjna, In ed. S. Juszczyk, *Edukacja medialna w społeczeństwie informacyjnym*. Multimedialna Biblioteka Pedagogiczna, Wyd. A. Marszałek, Toruń.

Strykowski, W. (1984), Audiowizualne materiały dydaktyczne, PWN, Warszawa.

Skibińska, M., Kwiatkowska W. & Majewska K. (2014). *Aktywność uczących się w przestrzeni Internetu,* Wydawnictwo Naukowe UMK, Toruń.

Tapscott, D. (2010). *Cyfrowa dorosłość. Jak pokolenie sieci zmienia nasz świat,* WSiP, Warszawa.

Andrzej Karbowski*, Anna Kamińska**, Krzysztof Służewski*

* Didactics of Physics Division, Institute of Physics, Nicolaus Copernicus University, Grudziadzka 5, Toruń, Poland

** Institute of Physics, Pomeranian University, Arciszewskiego 22A, Słupsk, Poland