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Chemistry around us: true or false? Chemistry in movies

La química ens envolta: vertader o fals? Química al cinema

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abstract

The paper presents an example of good practice in chemistry teaching using the project method at the upper secondary school level. The subject of the project is the chemistry in culture. The students' task was to find chemical contents in literature, news, movies and advertising, to analyze whether this content was chemically correct, to prepare scientific or research questions, to design experiments in order to check in practice the chemical content, to present results as a multimedia presentation. The main goal of this project was to raise interest in the subject among young people and to show the practical applications of chemistry in everyday life. The project was based on the movies and TV series: CSI: Las Vegas, CSI: Miami, Bones and MacGyver.

keywords
Chemistry, teaching-learning process, key competences, movies.

resum

L'article presenta un exemple de bona pràctica de l'ensenyament de la química mitjançant projectes a l'escola secundària superior. La temàtica del projecte és la presència de la química en la cultura. La tasca dels alumnes consistia a trobar el contingut químic en la literatura, notícies, pel·lícules i publicitat; analitzar si aquest contingut era químicament correcte, per tal de preparar preguntes de caràcter científic o d'investigació; dissenyar experiments per comprovar a la pràctica el contingut químic, i presentar els resultats en format multimèdia. L'objectiu principal d'aquest projecte era augmentar l'interès per la química en els joves i mostrar les aplicacions pràctiques de la química a la vida quotidiana. El projecte es va basar en les pel·lícules i sèries de televisió: *CSI: Las Vegas, CSI: Miami, Bones* i *MacGyver.*

paraules clau
Química, ensenyament-aprenentatge, competències clau, pel·lícules.

Introduction

Our interests contribute largely to our personality, as they provide stimulation to our daily activities and engagements. According to A. Gurycka's definition:

An interest is a mental quality taking the form of a directed cognitive activity of a specific intensity and manifesting as a selective relation to the phenomena surrounding us, specifically in:

1. Noticing specific qualities, problems.
2. Striving to learn, study, solve these qualities or problems.
3. Experiencing diverse feelings —positive or negative— related to the lack of, acquisition and possession of knowledge.

Children are natural investigators and always in the pursuit of activities that are interesting to them: they pursue a topic of interest until a satisfactory answer is achieved. Their natural

curiosity about the world makes them eager to experiment, to experience and to study as well as to build knowledge and acquire skills in this way. Unfortunately, this natural curiosity of the world as well as the desire to ask questions disappears over time (Bransford, Brown & Rodney, 2000; Klus-Stańska, 2006*a*, 2006*b*, 2008). Is it possible to extend this natural curiosity to develop interest in natural sciences, for example, chemistry? What can be done to stimulate young students to keep exploring and asking questions, and seeking new solutions and probing the answers? Can we better support these natural discoverers and their surprisingly sophisticated thinking in order to not lose the desire to discover answers and conduct experiments in order to obtain an answer? (Duschl, Schweingruber & Shouse, 2012). The maintenance and development of research student curiosity is a part of IBSE (Flick & Lederman, 2004; Krzeczkowska, 2011).

According to the European Union (*Key competences for lifelong learning in Europe...*, 2005) the basic competences for lifelong learning are supported by knowledge, skills and attitudes. Modern schools must realize the important task of creating diversely rich educational environment that allows for holistic development in all areas of the student's personality. The core curriculum for general education in Poland (Ministry of Education, 2008) states that teachers are responsible to create the appropriate educational environment during lessons or various extracurricular activities. This appropriately structured learning environment has the potential to shape and develop different skills, such as:

– Student's cognitive activity, especially abstract thinking.

– Formation of thinking that leads to an understanding of the acquired knowledge pertaining to chemistry and connecting this knowledge to various life situations.

– Creative modification of acquired knowledge through observation and solving of problems.

– Stimulation of cognitive curiosity, creative action and independence.

– Strengthening of the natural impulse to learn about the world, planning their own studies, testing their own hypotheses.

– Team cooperation skills, effective communication in various situations, presentation of their own point of view and accounting for the viewpoints of peers.

– Strengthening of concentration and logical thinking as well as the capability of drawing conclusions on the basis of experiments and own observations.

– Development of the student's scientific intuition, verification of conclusions, interpretation of observations.

Teachers well realize that their students acquire a lot of knowledge —whether they want to or not— from the world around them, particularly from mass media. Teaching science in the context of the real-world may become a powerful pedagogical tool. Classroom experiences need to be connected with students own experiences and interest. Chemistry topics should be relevant for students (Pilot & Bulte, 2006; Nentwig *et al.*, 2007; Parchmann *et al.*, 2009; Maciejowska, 2011).

The main idea and a description of the chemistry project

Through this project students had an opportunity to face real and interdisciplinary science problems. To solve the problem, students must apply the knowledge by linking chemical and biological concepts they have acquired so far, discuss the facts and confront ideas (Flint, 2011).

School students were divided into 4 thematic groups with the task of identifying:

1. Chemistry in literature.
2. Chemistry in news.
3. Chemistry in movies.
4. Chemistry in advertising.

Students groups were charged with the following assignments:

a) Find chemical content.

b) Analyze whether this content is chemically correct.

c) Prepare scientific question.

d) Design their own experiments to check the practice chemical contents.

e) Present a multimedia presentation, some experiments, some comments.

The project described above was preceeded by a survey conducted in September 2011 among school students from the upper secondary school No. 6 in Kraków. The goal of the research was to investigate the students' awareness of chemical content that can be found in movies and TV series. Arroio (2007, 2010) —among others— published a lot about a role of cinema, movies, TV series in science education pointing out the role of popular culture in developing students' motivation to learn science

In this initial questionnaire school students were asked to write down, as many examples of films with chemical content as they are familiar with. The students were given a minute to complete the questionnaire.

The school students'/ respondents' profile was as follow: N = 332 —15-17 years old—; N(girls) = 175; N(boys) = 157. The information about the results of the research —the number of indications for chosen examples

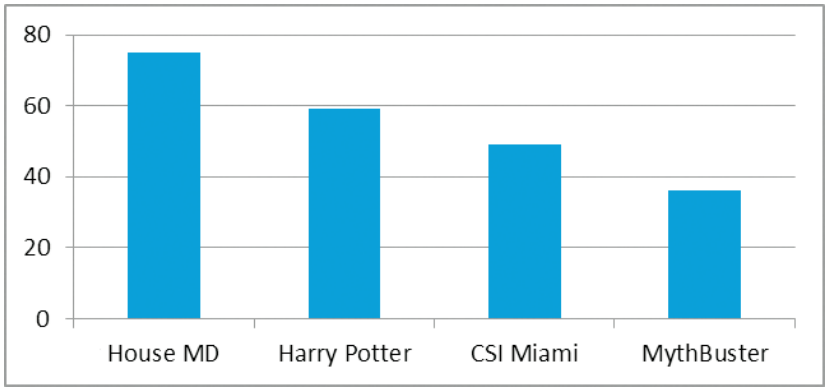

Figure 1. The four highest values of students' indications.

of a film/series— are shown in the fig. 1.

Some students' materials from the chemistry project

The results of the school students' project focused on chemistry in movies has been presented by secondary school students in the framework of a conference I Ogólnopolskie Forum Młodych Chemików in Kraków (Glina & Kierzyk, 2011).

Below are some examples of work produced by students.

A) Selected parts of students' multimedia presentation

Below some quotations from students works are presented. Students' multimedia presentations started with such stories:

«I collapsed onto the couch after two tiring hours of chemistry and turned on the TV, hoping that I would find something there that didn't require any thinking from me. A regular soap, or maybe a detective series. Clearly, this was not case, because while flipping channels, I was constantly encountering chemistry. Starting from the everyday chore of washing dishes and ending with MacGyver making a bomb from toothpicks, a glass bottles and an old hat…».

«In the world we live in, we encounter chemistry everywhere. Our lives are driven by the chemical reactions taking place in our organisms. However, chemistry also accompanies us in the television programs we watch. Thanks to the ingenuity of our heroes, we can learn how to survive while trapped underground in a car, or we remember some concepts from chemistry learned in school but forgotten in adult life».

«Although technological advances now make it possible to create a film from practically nothing and create a realistic unreal planet, this was not always possible. Film producers were often at the "mercy" of chemists or biologists who used natural means to create astounding and almost improbable spectacles. One example can be the pharaoh's snakes, which replaced "living stone"».

«And, although chemistry in movies from the fantasy genre does not appear in the exact meaning of the word, it is often present in them. The elixirs in the scene of *Harry Potter and the Half-Blood Prince* —fig. 2— are in no way different from the chemistry of today, except maybe for the fact that eyes of newt and hairs from the tails of mystical creatures are used instead of acids and bases. And the stunning colors of the flora in the scenes of *Avatar* —fig. 3— are only a "tuned-up" phenomenon of a luminescence which actually exists in the real world».

B) Experimental part

Crushed crystals of sugar

This experiment was prepared by school students (Mizierski, 1996). When the sight gets used to the darkness we will notice that the rubbed sugar glows with pale blue light. It's triboluminescence —emitting light caused by friction. Crushed crystals of sugar shine.

Laboratory glassware and equipment, reagents

– A glass.
– A spoon.
– Dry sugar.

Figure 2. The scene from Harry Potter and the Half-Blood Prince (2009). Potion lesson with Professor Slughorn.

Figure 3. The scene from Avatar. A walk through the forest with Neytiri.

Figure 4. The scene from CSI: Las Vegas.

Figure 5. The scene from CSI: Miami.

Figure 6. The scene from Bones.

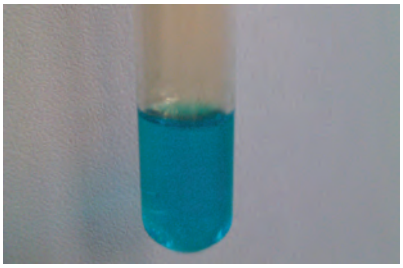

Figure 7. The results of the reaction of copper with concentrated nitric acid.

Description of the experiment, observations and conclusions

– Fill the glass until one fourth full with dry sugar using the spoon.

– Turn off the light and start to rub sugar against the sides of a glass. Not too hard because there will be no savings and not too weak because we will not see anything.

Green blood

This is an experiment found in *CSI: Las Vegas*, season 8, episode 15 —one of the scenes is shown in fig. 4.

Why did the blood turn green? Sulfohemoglobin is responsible for the green color of blood — inactive as an oxygen carrier, a derivative of hemoglobin, created as a result of a sulfur atom replacing an iron atom in the molecule.

Scientific question. What is the influence of sulfur contained in drugs on transporting properties of hemoglobin?

Invisible ink

This is an experiment found in *CSI: Miami*, season 6, episode 16 —one of the scenes is shown in fig. 5.

In this episode, Kelly is kidnapped. She consciously leaves traces for her friends, so that they know where to look for her. One of the methods she used was to write the location the kidnapper was taking her to on a piece of paper with invisible ink. She accomplished this using a water solution with soda —sodium hydrogen carbonate—, and grape juice was required by her friends to read the message. A similar effect can be achieved by writing with lemon juice. After that, only a candle is needed to read the invisible writing.

Scientific question. How to prepare invisible massage/drawing?

Laboratory glassware and equipment, reagents

– Filter paper.

– A paintbrush.

– $FeCl_{3(aq)}$.

– Ethanolic solution of salicylic acid.

Description of the experiment, observations and conclusions

– Use a paintbrush to draw something with the ethanolic solution of salicylic acid on a filter paper. Air-dry the filter paper, and spray it with the solution of $FeCl_3$.

– The purple drawing appears on the filter paper.

Carbon dioxide absorber

This is an experiment found in *Bones*, season 2, episode 9 —one of the scenes is shown in fig. 6.

Doctor Brennan is buried alive in a car together with Hodgins. So that the oxygen would not run out, Hodgins made an absorber of carbon dioxide using soda, ash and lithium.

Scientific question. The main factor in respiratory irritant resort is increasing concentrations of carbon dioxide, rather than reducing the oxygen content: true or false? Explain your answer.

Laboratory glassware and equipment, reagents

– Beaker.

– Lime water.

– A small plastic pipe.

Description of the experiment, observations and conclusions

– Use the small plastic pipe to enter the expired air to lime water —in the beaker.

– Cloudiness is observed.

– Carbon dioxide in the expired air reacts with calcium hydroxide; as a product insoluble in water calcium carbonate is obtained.

Sodium bomb

Found in *MacGyver*, season 1, episode 1. In this episode, the hero of the series used the reaction of sodium and water to blow up a wall.

The educed hydrogen self-ignites, and the more of it that is educed, the greater the chance for it to react with oxygen and for us to observe an explosion.

Scientific question. Do metals differ in reactivity? How the reactivity differences of selected metals may be shown experimentally?

Laboratory glassware and equipment, reagents

– A test tube.

– Concentrated solution of HNO_3.

– A piece of copper wire.

Figure 8. The scene from MacGyver.

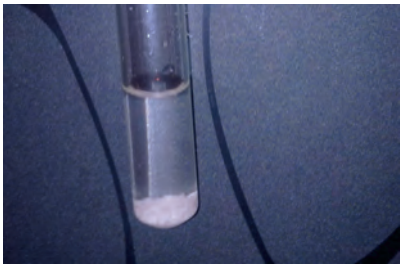

Figure 9. The precipitated silver chloride.

Description of the experiment, observations and conclusions

– Put a few drops of concentrated solution of nitric acid in a test tube containing a piece of copper wire. The solution becomes blue and brown gas gives off.

– Copper as a metal with a positive standard reduction potential reacts with a strongly oxidizing acid.

The result of the reaction of copper with concentrated nitric acid is shown in fig. 7.

Detecting chloride in water

This experiment was found in *MacGyver*, season 4, episode 5 —one of the scenes is shown in fig. 8.

This time, MacGyver has the task of checking for chloride in water. He uses silver nitrate to accomplish this. After the reaction, a white sediment of silver chloride settled on the bottom of the container.

Scientific question. How to check whether Cl^- ions are present in water? How to remove chloride ions from wastewater?

Laboratory glassware and equipment, reagents

– A test tube.

– $AgNO_{3(aq)}$.

– Sample of water.

Description of the experiment, observations and conclusions

– Put a few drops of aqueous solution of silver nitrate(V) to a test tube containing a sample of water. As a result, white precipitate is observed.

– Cl^- ions are present in the analyzed water.

The result of the reaction of Cl^- ions with Ag^+ ions is shown in fig. 9.

Student' opinion about that chemistry project

«["Chemistry in the movies"] is an interesting idea for meetings with school students as a part of a broader series of *Chemistry around us*. During meetings "Chemistry in the movies" the students may engage in finding TV shows, series, or films that include chemistry investigation. This activity may even provide a great argument for school students why they must watch TV. When parents have complaints that they spend too much time in front of the TV, this would be a great argument».

«MOM, it is the start of my scientific work!».

Later on, at a meeting with the teacher, students presented their discoveries and informed others, what information they had found on the subject and whether this information seemed to be scientifically correct —true or false. This had to be accompanied by an well-designed chemical experiment to confirm their thesis.

In the authors opinion, the students improved in a variety of skills such as their problem-solving ability: with problems that are interesting to them in a creative way, an ability to pose hypotheses and draw conclusions on the basis of conducted experiments, developing his/her interests, searching for information in a variety of sources, cooperation in a group which include sharing observations, presenting their own viewpoints and respecting the views of others.

Conclusions

The results of the project were presented at a special scientific school meeting organized for other students and parents. Based on personal observations and discussions, it is obvious that the subject of the project was well accepted by participants. They were interested in the large variety of chemical issues mentioned in movies and TV series. Also the audience considered the results interesting as well. The project allowed students to realize the presence of chemistry in everyday life. The results of the project will be used in the future to make chemistry lessons more attractive and interesting .

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List of the internet addresses

Fig. 2
http://jordin.wrzuta.pl/obraz/2lvtf1eYzCY/eliksiry_z_p.slughorn_em
http://c.wrzuta.pl/wi8840/11bc7302001639a648b2aeec/eliksiry_z_p.slughorn_em
Fig. 3
http://images.eonline.com/eol_images/Entire_Site/2010724//425.avatar.lr.082410.jpg
Fig. 4
http://ecx.images-amazon.com/images/I/51CL36v9e6L._SL500_AA300_.jpg
Fig. 5
http://www.onselldvd.com/media/import/img/left.CSI-Miami-Seasons-1-6-DVD-boxset.jpg
Fig. 6
http://i39.tinypic.com/2juvbr.jpg
Fig. 8
http://thumbnails.cbsig.net/CBS_Production_Entertainment/CBS_Production_Entertainment/2009/06/19/Classic/MacGyver/Season_1/clips/Webclips/82/115/CBS_MACGYVER_006_CLIP3.jpg

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