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Increase in Attractivity of Natural Sciences in Primary Education

1 Introduction

The Czech Republic has been solving a long term issue concerning decreasing interest in the study of natural sciences. Causes of the problem are being identified, but more importantly, the ways leading towards the increase in attractivity of this field. The causes of disinterest followed by the orientation towards humanities are possible to identify as early as in the initial years of compulsory school attendance. The first cause is noncritical adhesion to curriculum systematization related to the structure of the actual field; other causes which contribute to the loss of interest and motivation to study are: premature mathematisation, excessive and early emphasis on symbolisation, overuse of traditional teaching methods, formal character of lessons without corresponding applicability in practise, insufficient use of ICT tools, or even the restriction of ICT usage to avoid its misuse during lessons, etc.

2 Compulsory School Attendance

The phenomenon called compulsory school attendance is to blame. Yet, it all started rather differently to what it entails nowadays. Maria Theresa issued the General School Rules which included a statement recommending parents to send their children aged 6-12 to schools. However, it was a mere recommendation, as the truly "compulsory" school attendance (only for boys at that time) was introduced 30 years later by Francis II, the grandson of Marie Theresa, sometimes also referred to as Francis I (Žena in, 2017). Nevertheless, the aim of the present paper is not to map the history of compulsory school attendance, hence its contribution to the literacy in our environment is undeniable, but to analyse the actual implication and the word "compulsory."

The term "compulsory" is derived from the expression of obligation, meaning a specific moral relationship and ethical norm defining the **necessity** of an action, or a moral bindingness to respect and follow the given norm (Říman, 1987). In the context of schooling, the term imposes seemingly positive character, as well as signifies that to acquire all possible literacy means is a significant contribution to foundations of individuals' education. Furthermore, for a young person it manifests a springboard to the process of further self-perfection. However, the question is whether a young person thinks equally. From an ontogenetic perspective, pupils undergoing compulsory schooling are to a large extent located

in the period called “autonomous.” Considering it is the school (and puberty) age, the autonomous period is characterized not only by increasing behavioural awareness, but, according to Janiš, Kraus, and Vacek (2008), it is necessary to take into consideration gradually increasing criticism, manifestations of resistance, and the disagreement on the educated side, and considerable patience of the side of the educating ones. The above mentioned analysis leads to a series of conclusion signifying a considerable connection with the results of educational activities. The aim should be to seek such forms, methods and approaches to education which would result in the elimination of the aforementioned behaviour, including the increased criticism, or the manifestations of resistance and disagreement.

One of the possible discussable themes in this context is the traditional curriculum (in this case most importantly Chemistry lessons). Firstly, the used format is characterized by the inclusion of the themes that are highly logical and operational thinking demanding. In other words, we speak of mathematisation of lessons or their excessive symbolization. However, according to Piaget, operational thinking is developed later and a number of students experience great difficulties when facing the abovementioned curriculum, which results in the loss of motivation to study. We believe that this age group should be presented such curricula which are motivating and provide students with satisfaction in the form of applicability and simple utility in everyday practice. Such themes can be found sufficiently in Chemistry, yet they usually do not conform to the traditional system. The primary issue is thus the motivation of students, while the curriculum can be adjusted later during the course of secondary school lessons.

3 Ways to Motivational Chemistry Lessons

Contemporary education is accompanied by many changes predominantly connected with curricular restructuring. The aim of the restructuring is above all the support of more complex approaches to educational content realization, including the possibility of its interconnection. It further presupposes the choice of various educational approaches, various methods and forms, and the utilization of all supporting elements in concordance with students’ individual needs.

However, it means that the support of education (especially its material aspects) closely corresponding with creation of particular projection structures connected with positive motivation of students and safeguarding applicable aspect of teaching, is necessary to be

sought also outside of schooling, school offices and premises, e.g. in institutions that are being created for such purposes. Among such institutions can be listed museums, experimentaria, science centres, or similarly aimed institutions. These share aspects of various collections of experimentation objects or aids, often incorporating historical aspects and signifying often insufficiently used gnoseological potential.

3.1 Aquarium as a Motivational Tool to Teach Natural Sciences

Almost every child (from our perspective a subject being educated) in a certain stage of their development longs to have a piece of nature at home. Mostly this deep interest suddenly kindles and sometimes also quickly extinguishes. Children are testing what attracts them. They are gaining information concerning their prospective jobs. Each test, successful or failed, plays a role in their development. We must not even unintentionally contribute to the unsuccessful experience. The reason can be the issue concerning our lack of time. We miss patience and empathy with children so we cannot learn and experience their successes and failures with them. If children are not supported by parents. They can lose interest after initial failures (Plecitý, 2008). Plecitý sees parents' role in child development process as unsubstitutable, and sees their significant potential also in children's education. However, it is commonly known that parents must meet predominantly economic demands of the family, and an aquarium in this sense becomes a costly and redundant investment. The solution is provided again by Plecitý: I consider group Aquaristics as the most effective element while bringing up children. Aquaristics enables the feelings of joy from one's labour and the ability to communicate life problems. Noble activities of a child focused on further understanding of the laws of nature simplifies and expands communication in group by including nonverbal elements, and brings relaxation from everyday routine and stress. Aquaristics can be inspiring for children to meaningfully spend free time by revealing their own abilities and expanding their skill repertoire (Plecitý, 2008).

A clear signal for building an aquarium at school, setting up an interest group which would via its leader integrate schooling into practice. The subjects could then be within the School Educational Programme called "Applied Chemistry," "Applied Physics," "Applied Biology," Geography, etc. Philosophizing over the aquarist perspectives in the context of education can be supported again by Plecitý. Creativity is considered as one of the most significant human needs, which is being greatly neglected nowadays. Children have few creative hobbies; they are consumers passively waiting to be entertained by somebody else. They do not sufficiently realize their identity. They do not enjoy themselves a lot. Especially for children and young

adults, creative process is a natural mans to express their feelings and attitudes towards the world and themselves – it is a means of self-knowledge. This natural human expression applied in Aquaristics surpasses the natural giftedness or learned skilfulness to provide floor for children's fantasy, the adventure of getting to know something new, and encouragement for creative self-expression (Plecitý, 2008).

It is therefore thoroughly logical that Aquaristics is a supporting tool for teaching Biology. It enables getting to know exotic plants and animals, but mainly their own environment, life manifestations including procreation in conditions of dynamic balance of a created system, and other life-characterizing requisites, such as illnesses and their treatment, intra- and interspecies social relationships, etc.

The methodology of education in given conditions has been already elaborated, and observations and demonstrations are applied, as described by Bílek (2009). Objects of phenomena we observe must often be described. It is necessary to lead pupils and students to close observation followed by the expression of the observed so that the description is neither elemental nor mentioning only most striking aspects, which could be insignificant. To avoid superficial descriptions, students must be guided to detailed observations to notice inconspicuous feature escaping the first look. One of such teaching methods can be identified in Fig. 1, where a group of students from Siam observes sea creatures in an 83m long submarine tunnel (E-akvárium, 2017).

To put it simply, aquarium and Biology are connected. It is, however, less known that the same can be said about aquarium and Chemistry. Hieronymus (2010) posits that changing of water is often forgotten to be dangerous in certain ways. Besides the damage to fish mucosa as result of changing too large amount of water, another danger is ammonia poisoning. The ammonia poisoning appears when changing of water has been long time postponed. The pH value of aquarium water often naturally drops. During proteolysis ammonia NH_3, respectively ammonium cation NH_4^+ is created. If the pH of aquarium water drops lower than 7, the aquarium contains almost exclusively nontoxic ammonium cation. At pH higher than 7, the ammonium cation partly changes to highly toxic ammonium; the more alkaline water, the more toxic ammonium. Some fish death loss after changing water are not caused by toxic elements from water pipe, but from the created ammonium. Therefore, especially in large fish tanks with high amount of fish it is suitable to measure pH before changing water. If pH is higher than 7, its value after changing should be adjusted to around 7 (Hieronymus 2010). The passage suggests than Aquaristics is hence Chemistry (yet for many Aquarists it is still Alchemy). There is no surprise that many companies producing aquaristics technology

provide the market with interactive filters which besides filtration of mechanical particles include measuring systems for continuous measurement of temperature, conductivity and pH of aquarium water. Such filters are very close to research activities or virtual laboratories, whose basis will be an aquarium with the measuring system.

Fig.1 Schooling in a glass “submarine” tunnel in Siam.
(Photo: Roman Slaboch) (E-akvárium, 2017)

The similar laboratory is also mentioned by Bílek (2009): digital or virtual information access concerning collection or conservation objects, historical techniques, technologies, period procedures or conservation and restoration methods of both lay and professional public is above all a tool for advertisement of culture, cultural institutions and their collections to support research, educational activities and tourism development. It is insignificant if we speak about the “Project Aquarium” or the teaching of Applied Chemistry; what matters is to let students see the principles of dynamic processes, such as nitrogen circulation in an enclosed bio system, monitoring the influence of nitrogen compound on the growth of plants

while setting an aquarium, the health of fish inhabitants, monitoring the transformation of nitrogen compounds while setting of an aquarium, etc.

3.2 The Support of Quick-Process Experiments via ICT

It is generally known that a chemical experiment is one of the basic tools of knowledge in Chemistry. It is because for the educated subject the experiment is the source of information necessary for active perception, which is required as a necessary part of educational process.

Although chemical experiments are frequent themes of researches, the interpretation of results concerning the efficiency of experiment inclusion in teaching appears still and unsolved and even a never-ending issue. At present there are significant perspectives offered by processes connected with digitalization of obtained data; these would, nevertheless, require possible use of several non-standardized processes and most importantly, a different concept of used technical systems.

A large majority of experiment records done by ICT are nowadays only in a digital form. This format of record expands the possibility of its utilization in class. From the perspective of quick-process experiments, the elemental and crucial appears the function to set the digital record of an experiment in individual frames. Such frame analysis can be executed using video-recording freeware, such as VirtualDub, Pinnacle, etc.

One second of a regular recording results in 25 chronologically sorted frames; using a high-speed recording the number of frames is significantly higher (e.g. 400). Such a recording of quick-process activities has a significant impact on the analysis of the interpreted experiment, the understanding of the actual process which results in the creation of the insight in the realised process and enables the following interpretation of the experiment. The advantage of such a methodology is the ability of direct engagement of pupils in the process of the experiment evaluation, including their own technological devices (tablets or smartphones).

A suitable experiment for such a recording we chose a model process of an ignition engine. A transparent plastic cylinder was filled with petrol steam and covered with a light lid. After the initiation of the steam by a spark the steam was ignited and the lid “fired” (See Fig. 2).

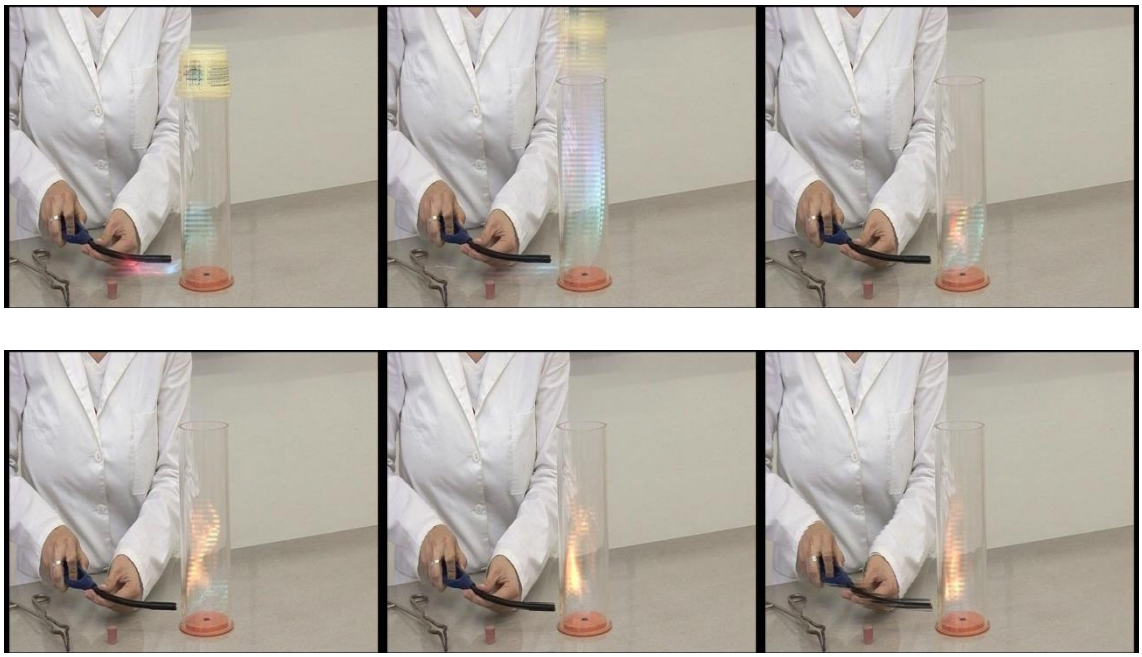
After the recording analysis the input parameters of experiment can be adjusted. In our particular case, e.g. changing the fuel compound, the type of steam initiation (electric spark,

flame, etc.). Consequently, another recording can be made and both versions then compared, using even detailed frame comparison of the given crucial experiment moments.

The video-recording and its potential analysis can be saved or shared for another use – self-study, revision, etc. Nowadays, we commonly experience and support sharing of experiment recordings in laboratory exercises on social networks.

If we want to ensure the increase in experiment efficiency and students' interest, direct engagement of students in the creation and recording of the experiments is a good idea.

Fig.2 – Frame analysis of a quick process (Photo: the authors)



4 Conclusions

Via deeply understood scientific knowledge, we can reach freeing ourselves from the manacles of narrow-mindedness and selfishness, reach spiritualization of our worldview, and cultivate our mutual relationship between ourselves and both animate and inanimate nature.

When a young man sets out on a journey of knowledge, they know almost nothing. They have an open mind and a heart longing to understand everything. Then the whole life they stroll the bank of the ocean of unknown collecting fragments of knowledge (Ullman, 2010).

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Key words: natural sciences, compulsory school attendance, motivational Chemistry lessons, quick-process experiments analysis;

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