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Cooperation in Science Education using the Science Garage, an Approach for Self-Motivated Science Learning

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Abstract

The education in various natural science disciplines like physics, chemistry, biology, integrated mathematics as well as technology and engineering has been for a long time disregarded as not practical, therefore not feasible in primary schools or early middle school grades. The same situation was acknowledged for related fields such as electronics and construction.

This under-representation of science and technology was generated over decades by various gaps in the education area, first has to be named the lack of useable supplies in schools, a problem which the author experienced by himself in his own school career. Second, a certain lack of will by school authorities and governments has to be found guilty for that situation. And third, there is, or in some countries after serious changes over the past years, one is tempted to say, there was a simple but overall lack of understanding of science and technology at the side of the teaching staff, both beginning and experienced teachers. Several South & East Asian nations show comparable lacks in some ways (Tippins, D. & Handa,V.; Tapan, M., 2009).

A fourth lack may be located in the fact that this issue is more easier originated in non-English-speaking countries with languages such as German, French or Spanish, because English is the modern language of science, therefore scientific achievements may not be getting access to the wider public as fast as it definitely happens in the Anglo-American regions of this world, as reported with the term "WMS = Western Modern Science" (Kawasaki, K. 2010).

Professional translations take its considerable time, and English as Second Language in science (ESL) teaching is a rather new, not ubiquitous standard in German-speaking nations and others (Edmunds, P., 2012). This was definitely the case in my home-country Austria one and up to two generations ago, also including the following issues. Other nations have experienced or are still experiencing a similar situation (Agarkar,S.; Upadhyha, B., 2009).

On the other hand the historical development of science and technology in the past four decades, especially their inclusion in so many fields of modern, every-day life affected a whole new generation of teachers working with kids, who want to prove their skills and smartness on various scientific or technical challenges. This, in reverse, had considerable effects on society and culture as an entity (Journal of Cultural Studies in Science Education, CSSE, Springer, since 2006).

The role of mass media must not be under-estimated at this point. The influence of science and technology on public awareness came (not only) with the rise of independent TV stations, which decided to show "science shows" in their weekly programs. At this time not a guaranteed success at all, it was great risk to do so, but it quickly turned into a constant positive performance. The high interest rates of young children in science and technology in Austria came particularly from one single TV- show aired in the mid-nineties called the "The Researcher's Express" (Brezina, T., 2005). In this format, an animated flying 19th.-century steam-locomotive crosses time and space, while real young children travelling inside, boys and girls alike, and perform various awe-inspiring experiments under the guidance of 2-3 researchers, which are actually actors trained by real scientists. The format became subsequently a worldwide success with synchronisations in over 20 languages.

This show did contain many interesting experiments, including a great deal of suspense, sparking curiosity not only for youngsters and children down to kindergarten level, but also for teenagers over 16 and their parents alike. A word which became fashionable only some few years after could describe it at its very sense: "Hands-on Science", a new concept back then when science was taught in school grades 1-4 mainly just theoretically, therefore titled by children as "just boring", or even ignored completely at all by the teachers.

As a consequence, "Hands-on Science" became now a standard method in our national science curriculum (IMST-Network), and the Science Dept. of my school Center developed in past years the concept called "Science Garage".

***Key words** : Young Children Science Education, Cultural Studies, Diversity and Heterogeneity, STEM*

The Concept of the Science Garage

It is commonly accepted within the professional education community and the general public as well, that hands-on experiences in those age groups often last a life-time such as sports, languages or music. In other words no theory can fully substitute practice performed by any students.
Since 2009/2010, out of a network of various schools and science clubs, some private, some institutional, in Vienna a concept was created to initiate pupil's motivation to develop interests in science and technology, bearing the name "*Science Garage*", sometimes also referred to as "*Researcher's Garage"* or in some cases "*Inventor's Garage"*.
Science Education for young children can be separated into 4 larger fields, which may be divided as proposed by the Taiwan Inst. of Compilation & Translation (Chen, Y.T. 2010) :

Table 1 *:*

Physical Sciences (Human Body, Hygiene)	Life Sciences (Animals & plants Cultivations)
Science Education for Young Children	
Technology (Tools, Mechanics, Appliances)	Earth Sciences (Natural Environment)

The aim is not only to stimulate this particular interest into science but to design it so enriching that it lasts for several years or even decades, most desirably for the following individual school careers, including any tertiary education.
Emphasis was laid on selected science chapters, new topics are being added each term and at present some included fields are:

Table 2 :

Thermodynamics	*&*	*Hydrodynamics*
Fluids & Gas Properties	*&*	*Heat & Cooling effects*
Properties of Solids	*&*	*Mechanics & Structures*
Chemical compounds	*&*	*Chemical reactions*
Acids + Bases	*&*	*Salts*
Electrical circuits	*&*	*Magnetism & Electromagnetism*
Kinetics	*&*	*Physics of Motion*

All those activities are "translated" for primary school pupils in terms and illustrations appropriate for their age, such as this selection may illustrate:
Table 3 :

"Nemo must Survive"	*"Fly your Yard Rocket !"*
"Steer your own Submarine"	*"Light for the Mouse"*
"Build like DaVinci"	*"Attract Stuff to a Screw"*
"Drop your Favorite Lego-Figure !"	*"Blow up a Ballon without your Mouth"*
"Red Cabbage shows its Colours"	*"Be a Water Music Composer"*
"Create an Underwater Volcano"	*"Make Liquid Rainbows"*

Easily to recognize are youth-orientated popular toys and figures derived from movies and other media, e.g. web-games and comics. Our newest topic being incorporated into the increasingly visited "*Science Garage*" is the field of Robotics, including Lego, Scratch, Rasperry Pi's and others.
A Series of Fact Manual Sheets is being currently developed for the use of accompanying teachers at various levels (for students, instructors, supervisors, team teachers) to achieve more insight into scientific explanations, thereby intensely using web-based discussion forums.
The increasing heterogeneity issue developed in urban and metro Vienna schools like in many other European cities over the past more than two decades has to be taken into account resulting in different approaches by pupils to science topics in terms of language and literacy (Wellington, J. & Osborne, J. 2001, Cobern, W.W. 1998).
What can be observed without exemption is that 3 different languages are created in our "Science Garage":

I.) The language of *instruction* (German).
II.) The *native* languages of the students (Turkish, Croatian, Serbian, Hungarian, Slovak, Czech, Greek, Russian, Hindu, Mandarin, a.o.).
III.) A "*Third State*" language as referred to by several scholars, or "Hybrid", yielding out of a mixture of I.) and II.), often understandable only by small highly diverse groups of pupils (Roth, W.M.2008).

Presentation to Intl. Youth Science Fairs

Based on serious interests into the Asian Science Education Communities such as (Seo, H. 2008, Rosenthal, J. 1996), in late Oct. 2012 the concept of the Science Garage was presented to the National University of Education (NPUE) in Pingtung, Taiwan, Science Education Department, as part of a study visit.
Upon positive reaction to this concept, I decided to develop further "Science Garage" topics, and to present them as well as discuss their implementation and outcomes in international science fairs. Participation and speeches at the ESI's (*Expos Science Intl.)* in Bratislava, July 2011 and Abu Dhabi, Sept. 2013 with well over 1000 participants, students an their accompanying teachers alike, from virtually all over the world resulted.
Very successfully turned out the *Adolescent Science Technology Innovation Contest* (CASTIC) in Nanjing, China where I could present the concept to a group of national science teachers. Future science fairs collaborations are in a planning stage.
At present, additionally efforts are undertaken to incorporate students with learning disabilities as earlier described in the literature (Ratanaroutai,T ,in Lee,Y.C. 2010).
The range hereby goes from language/speech-related to physical as well to mental disabilities.

Conclusions

The visit and collaboration generated on both sides several intentions to deepen relations in the field of primary science education not limited to core science & technology topics, but also considering heterogeneity, language and literacy issues as well.
As Abell, S. & Lederman, N. (2007) stated in their "Handbook for Advancement on Research in Science Education", the ultimate purpose of all those efforts is to improve science teaching and learning on a global scale. With such collaborations, those aims are truly achievable in the near future. Science educators should broaden their research on an international scale, and bring more cross-cultural studies into realization. They also should publish their national efforts in international journals, thus sharing it with the worldwide science educators community and scholars from other countries, and even more important, other cultures. In this way, such studies will not only affect science educational efforts, but also bring some light into the wide field of cultural studies in science education (Siry,C. et al. 2013).

Literature:

[1] Abell, S. & Lederman, N. (Eds., 2007): Handbook of Research on Science Education, *L. Erlbaum Assoc*., NY.
[2] Andersen, E. & Brown, A. (2012): The effect of heat: simple experiments with solids, liquids and gases, *Science in School* 24, 23-28.
[3] Agarkar, S. (2010): Combating Learning Hurdles Arising Out of Social Deprivation, in: *Science Education Research in Asia, Cultural Perspectives in Science Education CPSE, Vol 4, Ed.:Yew.Jin Lee.*
[4] Brezina, T. (1995-2005): The Researcher's Express, TV-Show, *ORF Austria*, Wien.
[5] Chen, Y.T. (2010): Science Education for Young Children in Taiwan, in: *SciEdRes.Asia, CPSE Vol4.*
[6] Cobern, W.W. (1998): Socio-Cultural Perspectives on Science Education, *Kluwer AP*, Dordrecht.
[7] ESERA 2012 Annual Report on Science Education Research in Europe, *Esera Publ.,* Utrecht.
[8] Hutchinson, C. & Bailey, L. (2006): Cross-cultural perception of assessment of selected international science teachers in American high schools, in CSSE, I., 657-680.
[9] IMST (Innovations in Math, Science, Technology) in Science Annual Report 2012/13&14/15, Univ. Klagenfurt, *AAU Press.*
[10] Kawasaki, K.(2010): Any language can be the medium of instruction of school science, but…: An Anti-Essentialist Investigation of Science Education , in: *SciEdRes.Asia*, *CPSE Vol4*.

[11] Lee,Y.C. et al (2010): Handbook of Science Education Research in Asia, *Sense*, Boston, Tapei. Cited as: *SciEdRes.Asia, CPSE Vol4.*
[12] NY Hall f. Science Publications (1999-2011): Evaluation reports, "tryscience.com" *New York Hall of Science*, NY
[13] Rosenthal, J. (1996): Teaching Science to Language Minority Students: Theory & Practice, *Multilingual Matters Ltd*, Levedon.
[14] Roth,W.M. (2008): Bricolage, metissage, hybridity, heterogeneity, diaspora concepts for thinking education in the 21 century*, CSSE Cultural Studies on Science Edcuation*, Springer.
[15] Seo, H-A. (2008): Factors Affecting High Achievers in Science and Engineering in Korea, in *Promoting Successful Science Education, 19th Symp. on Chem. & Science Ed.*, Univ. of Dortmund 2008, *Shaker,* Aachen.
[16] Siry, C. (2013): Co-Ed. of Cultural Studies in Science Education CSSE, *Springer*, NY, since 2006.
[17] Sobey, E. (2012): "kidsinvent.com & inventions-center.com", Redmond, WA, USA.
[18] Upadhyay, B. (2010): Seeking for Empowerement and Social Justice through Science Education*,* in: *SciEdRes.Asia*, *CPSE Vol4*.
[19] Wellington, J & Osborne, J. (2001): Language and Literacy in Science Education, *Open Univ. Press*, Philadelphia.
[20] Tapan, M.(2010)*:* Science Education in Bangladesh*,* in: *SciEdRes.Asia, CPSE Vol4.*
[21] Tippins, D. & Handa, V. (2010): Community Immersion as a Context for Relevant Science Teacher Preparation in the Philippines*,* in *SciEdRes.Asia, CPSE Vol4.*
[22] Expo Sciences International ESI2011+2013, www.milset.org
[23] CASTIC2013, www.cyscc.org.cn/castic