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Various Challenges of Science Communication in Teaching Generation Z: an Urgent Need for Paradigm Shift and Embracing Digital Learning¹

„Back in my time!” – Instead of Introduction

„The children now love luxury. They have bad manners, contempt for authority; they show disrespect for elders and love chatter in place of exercise.”

/Socrates, 469-399 BC/

As the intentionally provocative quote shows, Socrates was dealing with the generational conflicts already two and a half thousand years ago. although ancient Greece was featured by cultural productivity and economic prosperity (Hall, 2007) The period when the philosopher lived can be considered as the dawn of classical Hellenic civilisation: that time the Athens society was not suffering of crisis of values, the life of the inhabitants of the polises was organised along solid moral conventions. Despite of this Socrates named Greek youngsters as a frivolous gang. The dissatisfaction of adults towards teenagers – irrespectively to the socio-cultural environment and ideology – occurs in social history from time-to-time.² In this respect humanity seems to be a homogenous group, since it can be sensed as a general tendency that the following generation is held liable for any changes experienced on the field of human cerebrality. “Back to my time” – say our grandparents; this sigh shows implicit valuation and accusation: as if everything were better, more accepted, more „normal” in their youth. And who else could be liable for cessation of “normality” than the youth breaking up with morals and traditions?

This study does not intend to deal with this subjective and hard to evidence scheme of thinking. Rather it tries to call attention to that the success of handling the problem is definitely influenced by the knowledge on the factors behind the phenomenon and the ongoing reinterpretation of the definition of „normality”. It is not a secondary standpoint at all whether the changes to the attitude between generations - different characteristics, skills, competencies – are identified as deviancies, taken out from their context, or they are

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² During the past decades several researchers analysed the generation conflicts and the challenges related to coexistence of the older and younger generations (Esping - Andersen, 2002), its theoretical basis is defined on one hand by the classical sociological thesis of *Mannheim* describing the generations as social phenomena (Mannheim, 1952), and on the other hand by the definition of individual habitude given by Bourdieu (Bourdieu, 1977). On this field changes to the attitude is also measured by quantitative sociological methods.(Andres et al., 2007), but the gap created the deviating characteristics of generation X and Y (Yelkilalan & Ayhun, 2013), the distribution problem (Asheim & Tungodden, 2004), challenges represented by teaching students of different age (Billing, 2004), identity and values of diversified employees (Joshi et al., 2010; Parry & Urwin, 2011) and the successful economic cooperation of heterogeneous teams (Karp & Sirias, 2001; Glass, 2007) are also popular topics.

considered as borderline between sections and handled as a possibility offering new perspective. (Ng et al., 2010)

In my study I am reasoning for that since adoption of changes, tolerating and teaching each other are key elements of coexistence of different age-classes (West et al., 2002), it is reasonable to find the way for bringing the new possibilities of youngsters to the surface, for teaching them, and use their different competencies for the benefit of the development of the society. To achieve this the older generation is required to be open to digital catch up (Kolin, 2002), while they should not condemn the values of the youngsters and they should not prevent fulfilment changed of demands for obtaining knowledge. According to my thesis from the perspectives of economic, educational, political, labour market and cultural challenges of our days, recognition and conscious application of the possibilities hidden in mutual assistance and transfer of skills, viewpoints and experiences are unavoidable. Therefor in everyday life – moreover in pedagogical work – it is vital to find response to the following questions:

1. Is the way of thinking and behaviour of the younger generations form basis for worries indeed?
2. What are the main reasons of causing changes between the generations; who or which processes can be held liable for the transformation of values and attitude?
3. How did we handle these changes, how do we face the challenges resulting from such changes?

The study analyses these topics, primarily approaching the characteristics of generation Z deviating from that of the previous generation from science communication and educational aspects. Based on international and Hungarian research the paper gives brief review on the impact of our current time, the development of information society and technology on the world view and discrepancy of the different age-classes. I attempt to identify those characteristics of transferring knowledge, consumption and media usage, which are definite to development of the relation of persons born after 1995 to science, then I summarise the models of *Public Understanding of Science* (hereinafter referred to as PUS)³ relevant to generation Z. In the second part of this study I reason for paradigm shift in formal education and I give recommendation on the methodological framework of a progressive educational system, which is able to successfully meet the demands of the analysed age-class, and which can play a definitive role in forming the interest in science and preparedness of the digital generation.

³ The field of PUS is in seek of answer to the question how the population is related to the scientific product, what image media communicates about science, how and on what channels, with the help of what devices the relation between the non-professional publicity and the science community is created. (Bauer, 2009) The definition includes either the “*normative and practical definitions related to social understanding of science, or the main principles of this area of science, or the social and educational commotion, which rose after bringing up the problem; at the same time, the term is a position profile, and area of research and practise for academics and communicators.*” (Pintér, 2013a:23)

Coexistence of Generations in the Information Society

Formation of the *information society*⁴ has completely rearranged the access to the social resources and information (Beniger, 1986), what has significant technological, economic, employment and cultural aspects (Webster, 1997). While in the industrial era the devices and natural resources were definitive, nowadays knowledge provides the majority of the produced and consumed goods, the work defined by information processes become definitive versus the direct physical work. (B. Tier, 2014) The development taken place on the field of information processing, storage and transmission on one hand led to wide scope of application of digital technologies, while on the other hand to the convergence of telecommunication and IT in all segments of the society.

In the 2000s technology forms each and every segment of our life; accordingly it exercises a formerly unknown extent of stimulation and information pressure on the society accompanied with acceleration generational differences. (Rückriem, 2009) The structure of the world has become network-based, where internet, information technology and telecommunication have turned into a faith defining experience of the younger generations. (Castells, 2006) This process not only detached the younger generations from the traditional, direct human communication media, but it has substantially changed their relations, cognitive and learning methods. (Nyíri, 1999) Digital experience, network-based interaction and unlimited communication have become a basic experience and daily need of those born on the turn of the millennium. (Castells, 2006) the value of knowledge and media, and knowledge vital to self-maintenance in the knowledge society built on lifelong learning intruded into the expediential values. (Gergátz, 2009) Therefore the borderline between childhood and adulthood is less sharp: a child browsing the internet consciously makes his way in the same media as an adult; this results in interflow of the scope of entertainment and work. (Nyíri, 2004)

It is an elemental principle of sociology that each and every generation lives history in its own characteristic way: the events and features of the era get built in its identity. (Howard, 2000; Urick, 2012) While formerly the generation forming impacts were nurtured mainly by history, nowadays they rather start up from the direction of technological development. (Csepeli, 2006) While – on the contrary to the former technologies – the technology of the information society has deeper and more comprehensive impact on our life, thus the distance between the approach of younger and older generations, between the “old” and the “new” is growing. (Gergátz, 2009) Basically this is the main reason of the generation gap; and this is what initiates the generations to start conversation with groups maintaining other identity.

⁴ Closely related concepts are the *post-industrial society* (Bell, 1974), *post-fordism*, *post-modern society*, *knowledge society*, *telematic society*, *information revolution*, *liquid modernity*, and *network society*. (Castells, 1996; 1997; 1998)

Considering that the newly appearing mechanisms of obtaining knowledge has totally transformed the relation of the new generation to the world and the former generations (Combi, 2015), from the 2000s identification of the reasons of the conflicts between the generations and specification of the general characteristics of the different age-classes are the most important tasks of generation research. (Masnick, 2013) in the course of developing the methodology, in addition to exploring the phenomena, finding the practical aspects of the generational conflict, and selection of the methods for problem management successfully serving social interests are also important viewpoint. (Lengyel, 2003) Yet before giving exact methodological recommendations on alteration of the former education system, in the next chapter I define the generation Z and I will briefly describe its relation to technology.

Media Usage of the Digital Natives, their Characteristics and the Technology

The basis of generation research is that the certain generations have different so-called *cohors experiences* – characteristics defining the attitudes of the persons born at the same time and similar needs. (Simon, 2007) Due to the different socio-cultural background the common experiences and values – join the members of a given age-class in a loose, but definitive way. Despite heterogeneity e definitive trend can be observed along the formation of value preferences; this provides possibility for the social scientists to connect individual decisions and identify the differences between youngsters and elder people. (Pilcher, 1994)

Although the literature related to the field of science is not uniform in respect of the terminology for different generations and dates of birth, the majority of research deals with analysing primarily the Baby Boomers born between 1946-1960 (Howe & Strauss, 1991; Landon, 1980; Owsram, 1997; etc.), *generation X* born between 1960-1980 (Miller, 2012; Markert, 2004; etc.), *generation Y*, also called *millenary generation*, born between 1980-1999 (Horovitz, 2012; Strauss-Howe, 2000; etc.), and generation Z, also called *iGeneration*, *Pluralist* or *Digital Generation*, bringing up the most of interdisciplinary problems nowadays, born after 1995 (Horovitz, 2012; Turner, 2015; Dupont, 2015, etc.)⁵ Since this study approaches the impact of information society on the characteristics of generation Z deviating from those of the former generations from science communication and educational aspects, I will discuss more detailed the characteristics and media usage of the ones born at the end of 1990s.

Generation Z is a new type generation; either in its content consumption, socialisation or identity the developing info-communication technology plays a significant role (Ipsos MediaCT, 2013) According to the findings of a Hungarian research (TÁMOP-4.2.3-12) analysing the costumer behaviour of young people aged 15-25, this age-class spends 5-6 hours daily with use of media; basically the use of mobile carriers, smart phones and tablets is the most typical (Ipsos MediaCT, 2013), while in media usage at home the dominancy of

⁵ Naturally the analysis of the next, so called Generation Alpha or *Generation Glass* also raises several questions from the aspect of terminology and sociology as well; this means a more and more definitive focus of research for the sociologists. (McCrimdell, 2010; Williams, 2015; Sterbenz, 2015; etc.)

computers can be observed. (Guld & Maksa, 2013) Popularity of these devices can be related to the Internet: from the web 2.0 applications available through the network the social sites, blogs, video sharing sites, chat programmes, news sites and file sharing sites are the most important. However, classical mass media were not crowded out from the daily routine of young people, yet their role was revaluated and their consumption has become more superficial: radio and television can be related to background media usage, while the loss of importance of newspapers and magazines is reportable. (Guld & Maksa, 2013) The members of generation Z set up the world surrounding them via mutually edited contents, shared info and comments; they take part in discussions catching their attention assertively and actively. (Tari, 2011) Of course not only they form the environment, but also the environment is greatly forming the cognitive, affective, conative and social senses, daily routines and social relations of the ones born after 1995. (Tari, 2011) As a consequence, while in the life of former generations the real offline and online presence existed marginally separated, for the first global and digital age-class these two things are harmonically joined: technology interweaving the entire life and being permanently present has become one of the most important device of expressing ones identity. (Ujhelyi, 2013)

The Basic Problem of Educating Generation Z

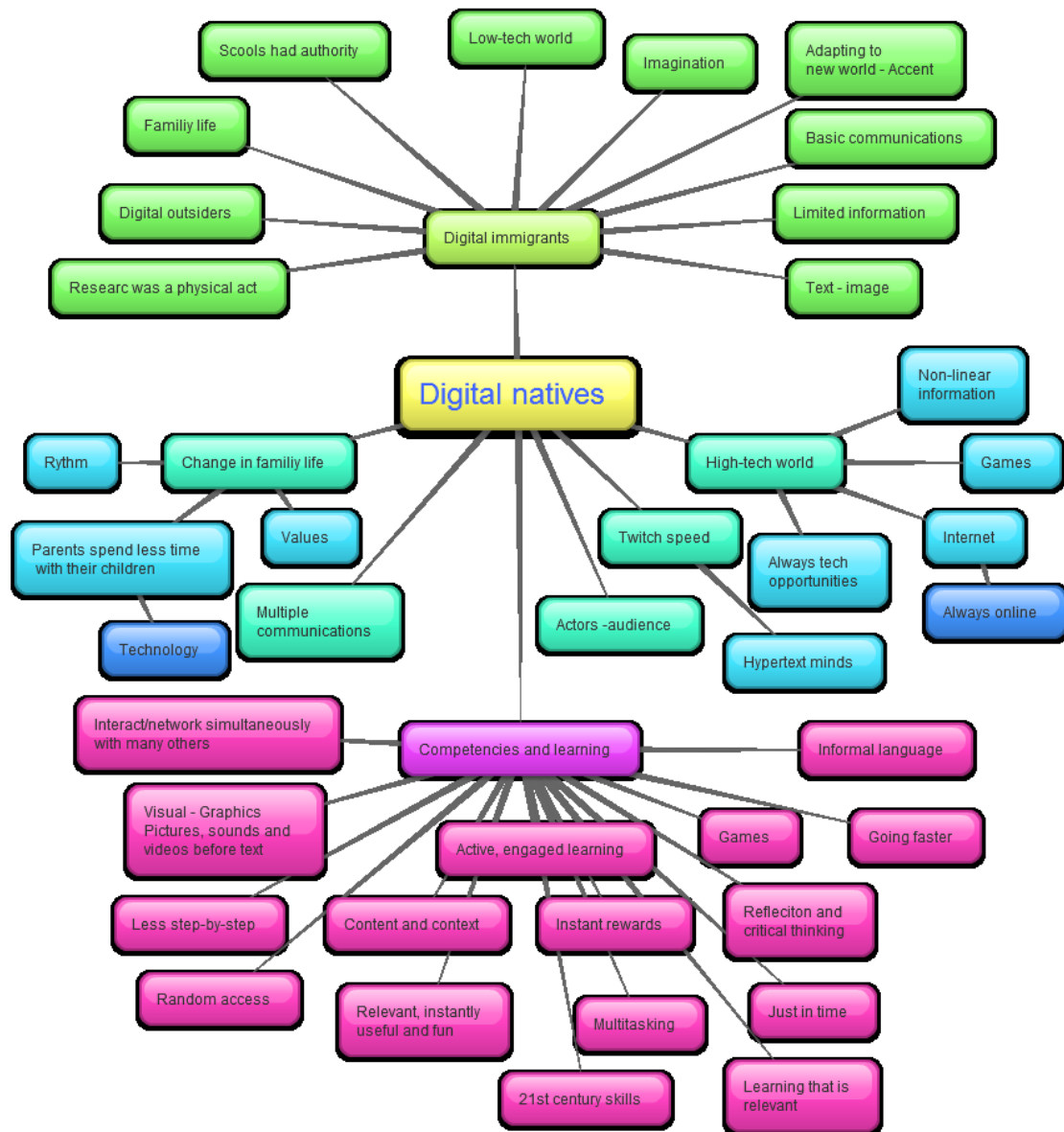
From the viewpoint of science communication the basis of successful education of generation Z lies in the professional discretion that its members – on the contrary to generation Y or X – did not start to adjust to the digital word in a certain section of their life on the effect of professional pressure, but they were born in a dynamically changing environment, which offers the most developed hardware and software solutions to resolve everyday problems. That is why *Mac Prensky* calls this age-class as “*digital natives*”, whose demand on receiving information has changed pragmatically. (Prensky, 2001:1) The brain of the members of generation Z has not only developed in a different way than that of their ancestors (Trunk, 2009), but due to the frequency of their interaction with the environment they also process the information differently (Prensky, 2001). While the older ones adjusted to the changing digital environment through individual learning mechanisms, generation Z has no learning “accent”, its members speak “digital language as their native language. According to *Prensky* the teachers and researcher who are active in our days can rather be considered “*digital immigrants*”, since they are learning the new “language” only now.⁶ (Prensky, 2001:2).

Thus generation Y or X in a certain extent unavoidably lives in the past: it will be only an umpteenth idea of its members to refer to the new technology whenever they need solution and they adapt the phenomena of the digital world less naturally than the ones born at the end of '90s. (Prensky, 2001) For illustration of the conflicts influencing the education in its entirety I use the below chart of *Kristiansen* (Kristiansen, 2011), which schematically

⁶ According to the basic principle of socio-linguistics any language knowledge, which we obtain otherwise than our native language, i.e. during our life, is stored at other parts of our brain, and can be recalled in other – sometimes less successful – ways. (Gass & Selinker, 2008)

compares the different characteristics, skills and competencies of the digital immigrants and the digital natives.

Figure 1 – A Thinking map of Digital Natives



The conflict resulting from the above chart – supplemented with the paradox situation that as regards to great basic formulas the society can already be considered as information society, yet the superstructure of public education still follows control structures of the industrial era (B. Tier, 2014) – represents one of the greatest problems of science communication. Since the digital immigrants – who in their own time learned slowly, coherently, individually and profoundly – are less rewarding to those new skills which the natives naturally own resulting from the everyday interactions. (Prensky, 2001) If we add up this with that the scope of expertise transformed due to the structure of knowledge society, the ratio of mental workers grow on the labour market, and the significance of skills related to information and communication technologies (ICT) (Hinrichs, 2000), the urging need of

reworking the education becomes evident. In the 21st century emphasis is placed on fast, accurate and productive work: increasing complexity of the tasks expects creativity, flexibility and ability for team work from the youngsters becoming professionals in the 2010s. (Cisco, 2009)

Changing demands for learning

When finding any problem to be resolved the “dotcom” kids living in virtual community already do not expect response from pedagogues and schoolbooks which were formerly considered as primary source of knowledge, but – since they have natural skills to operating telecom devices, excellently navigate on the internet and easily establish relations – they get solution from each other or browse the internet to seek for it. (Duga, 2013:3) This is also supported by the *EU Kids Online I-II* research: the time spent with browsing the internet by the young generation is not spent only for entertainment, communication and consumption of contents, but, subject to the type of the tasks their presence on the web promotes the process of learning as well. (EU Kids Online II., 2012)

Also *Dunkels* and *Zipernovszky* discusses the possibilities of learning via internet in details; their research discovers that social sites, such as *Facebook*, *Skype*, *LinkedIn*, or *Google+* offer new forms of learning for common work. (Dunkels, 2007; Zipernovszky, 2008) Besides social sites the microblogs – *Twitter*, *Tumblr* –, and also the video, photo or sound sharing sites, such as *Youtube*, *Picasaweb*, *Flickr*, *Ustream* or *iTunes* are also popular. Generation Z uses presentation applications, such as *Prezi*, *Slideshare*, *Googledocs*, etc., as well, but on the contrary to generation X or Y also the use of different framework systems, online learning communities and virtual environments are not unknown to them. (Duga, 2013:11) There are several reasons for what the sites are successful; on one hand the “hyper” mass of text on the web stimulates the *natural, individual* learning, the process of obtaining knowledge resulting from instinctive curiosity and internal motivation without the control of any professional. On the other hand it improves both logics and collective informal learning, what is based on permanent exchange of experiences featuring the virtual communities. (Duga, 2013:6)

The ones born at the end of 1990s actively create informative contents, since they prefer multimedia communication to written texts; accordingly also their processing methods are non-linear. According to a survey of the *Budapesti Üzleti és Kommunikációs Főiskola* the members of generation Z - primarily resulting from the speed of search drives – prefer the fast obtainable information (HVG, 2014), they like to see the result of their work immediately and expect instant feedback. Interaction and empathising experiences are important to them. They are able to deal with several things simultaneously and they are effective in organising their work, they get the information what is in their interest in diversified channels and quickly. (Bessenyei, 2007) At the same time the survey also highlighted the processing of longer text and verbal restoring of the knowledge text cause difficulties to them; they consider the lessons supplemented with spectacular visual elements as easier to remember. One-direction communication causes problem to them,

therefore they find it difficult to follow theoretical deductions and tangible, practical examples are important to them. (NOL, 2014)

Thus technical development has greatly changed media usage and characteristics of the digital natives, what led to a more and more defined student-attendee requirements and transformation of values on the labour market, while this has impact on the educational system as well: members of generation Z require substantially different methods and curriculum. (Jukes & Dosaj, 2006) Moreover the gap between the capacity hidden in the digital generation and the available professional, device and solution environment is growing (Z. Karvalics, 2013), this gap gives new tasks continuously to the ones wishing to modernise the formal education. Before oi start to discuss the particular professional aspects of the science communication conducted with the ones born after 1995 and my methodology developing recommendations, I summarise the aforementioned based on the table of *Jukes and Dosaj* (Jukes & Dosaj, 2003), particularly the major differences between the digital immigrant teachers and the digital native learners.

Table 1 – The Differences between Digital Native Learners and Digital Immigrant Teachers

Digital Native Learners	Digital Immigrant Teachers
Prefer receiving information quickly from multiple multimedia sources.	Prefer slow and controlled release of information from limited sources.
Prefer parallel processing and multitasking.	Prefer singular processing and single or limited tasking.
Prefer processing pictures, sounds and video before texts.	Prefer to provide text before pictures, sounds and videos.
Prefer random access to hyperlinked multimedia information.	Prefer to provide information linearly, logically and sequentially.
Prefer to interact/network simultaneously with many others.	Prefer students to work independently rather than network and interact.
Prefer to learn „just-in-time.”	Prefer to teach „just-in-case” (it’s on the exam).
Prefer instant gratification and instant rewards.	Prefer deferred gratification and deferred rewards.
Prefer learning that is relevant, instantly useful and fun.	Prefer to teach to the curriculum guide and standardized texts.

The gap between the competencies of students and solution environment of schools

Due to the changing learning demands of generation Z the importance of the role of internet and digital technology in education is unquestionable nowadays. Internal learning motivation features the self-development of the members of this generation, their interests are diversified, what is reasoned by that an enormous quantity of impulse influence them since the day they are born. (Turner, 2015) They are attracted by several scientific – mainly technological – topics; they seek for them more purposefully than those borne before the '90s. Their approach to learning, getting informed and to knowledge itself has also radically changed. (Oblinger & Oblinger, 2005) An increasing ratio of their knowledge results from other media than schools: beginning with different traditional media, through museums, scientific festivals to meetups, events popularising science and other non-traditional science communication sites.⁷ Although the so-called *edutainment*, i.e. obtaining knowledge in an entertaining form is an important demand on their side (Demers, 2005:143), yet they are critical users of media, they avoid advertisements and are aware of the general hazards of media. In their knowledge obtaining mechanisms they prefer simultaneous interaction and relevant, promptly usable knowledge having practical significance. (Bessenyei, 2007)

These changed generational characteristics result in that an effective education must reevaluate its current situation, it must consider that from the several learning environments it represents only one – and not even the best – option, and that science communication must adjust to the cognitive changes going through in the mind of youngsters and their consumer demand, also in its methodology. As the today students are not the same as the ones for whom the current education system was set up (Prensky, 2001), therefore in the education of generation Z it is vital to establish an environment and information channels, where development similar to that unnoticeable learning of their childhood can be implemented. (Papert, 1996)

As the *Netgeneráció 2010* international survey reveals, since the members of the age-class get to resolution of problems individually, not on a uniform and previously defined route, the educational institutes must review the input and output requirements and carrier milestones set up for the students several decades earlier. (Hartyányi, 2010; Anderson 2011:126) The traditional basic skills – writing, reading, counting – were added up with several new kinds of skills, the development of what would be worth to be inserted in the curriculum. (Z. Karvalics, 2014) The key to generation Z's understanding of science is the development of dynamic, colourful, creative projects providing the joy of success through partial results. Improving the learning attitude of the age-class – besides visualisation –

⁷ Non-traditional scientific sites provide the experience of active observation and build also on the technical skills, practical common sense, attention sharing and troubleshooting skills of those born at the end of 1990s. Until meeting-up of the pedagogical work going on in schools, the potential hidden in environmental, informal education provided out of school lessons is able to compensate – even if only partially and temporarily – this generation. While the quantity of marketable knowledge obtained in normal education is decreasing due to the often outdated methods, the other channels used by the students provide them growing knowledge.

involving the students and cooperative methods allowing more effective transfer of knowledge also have important role. (Fehér & Hornyák, 2010)

What model should be followed to educate students born after 1995?

It is a fundamental principle of political economy that scientific and technical knowledge is the main drive of social development: without up-to-date information the knowledge of human civilisation could hardly improve. As it is also shown in this study, accurate definition of knowledge is not easy, since it units not only epistemological, philosophical, pedagogical, psychological and economic viewpoints, but the term seems to have different meaning for the different age-classes. As a general definition it could be stated that knowledge is the mass of systematised gnosis created about the world surrounding us, obtained mainly by experience, accumulated since the dawn of civilisation and transferred from generation to generation. A kind of product, what has clear, but not always quantifiable values, and as such it is marketable, i.e. can be understood along the rules of market demand and offer. (Palugyai, 2012)

In case the characteristics of generation Z are also taken in consideration the above definition requires a plastic timely interpretation: the world surrounding us is continuously changing, and these changes impact us as well. Due to the use of info-communication technologies the ones born at the end of 1990s understand knowledge “*obtained by experience*” in a different way than generation X or Y, moreover the labour market, which is getting digitalised considers expertise on other fields as marketable than before. One of the characteristics of the knowledge-based society is that in order to successful self-assertion its members must face the mass of information surrounding them, and must become able to select and find the relevant information (Molnár, 2008), than apply the knowledge obtained this way properly for their purposes.⁸

The continuously expanding mass of information from the information boom and appearance of the new type students represent a great challenge for the existing knowledge systems. Since labour market integration and everyday decisions of generation Z is significantly impacted by the quality of education and the channel of scientific interaction, it is worth that pedagogues, scientists and curriculum developers to give up on the former teaching methods and work out such training and information transferring and educational environment, which are customised to the requirements of this generation. (Oblinger & Oblinger, 2005) On comparing the differences in methodology of educating generation Z and the traditional teaching paradigm, it occurs that the ones born before the 1990s obtained their qualifications fixed to a place, based on fixed teacher and student roles. Education of generation X or Y was primarily based on transferring universal, fact-focused, isolated masses of knowledge and summative valuation, while the cognitive tools of the students characteristically included memorising and subsequent recall. (Brown, 2005)

⁸ Lewenstein uses the *Rational Choice Theory* for this process, what focuses on the problem that from the uncountable amount of knowledge which are the ones average people should inevitably know so that they can positively influence the quality of their life in a world interwoven with science. (Lewenstein, 2003)

Public Understanding of Science uses the term *Deficit model* for this one-direction information transfer, what was formed based on the idea that the head of everyday people is empty. According to this model scientists and teachers can be considered as the main source of knowledge, they are the umpires to decide on what extent it should be intermediated to the audience, the students. This situation leads them to a clear action programme: their task is not else than “fill those heads”, i.e. teach the possible most science to the students, the laymen in order to improve the social opinion on science. (Gregory & Miller, 1998:11)

As also the researchers of science communication admitted in the ‘90s this model failed at three points. Firstly, when the information is questionable within the science community, thus is in the course of formation. This is a problem primarily because the knowledge required by the society – especially by generation Z – less belongs to theoretical physics, history or biology, but they are rather conceptualised on the level of everyday practical decisions, e.g. on the technology being continuously “on the conveyor-belt” or on the field of medicine what is accompanied by passionate professional disputes. (Harlick & Halleran, 2015) Secondly, the Deficit-model discusses the scientific problems without defining the context, what – as we have formerly seen – is a basic factor of the interest of generation Z.⁹ Thirdly, the digital generation rather demands a custom-made science communication adapting the changes of the world, offering abundance of possibilities and based on interaction, than an outdated pressurising education model, which is rigid and independent of the technological environment. (Brown, 2005)

Instead of isolated facts generation Z requires the joy of discovering, micro-level understanding and knowledge embedded in context. Since “information” and “knowledge” do not mean the same: Knowledge is information understood in its context. (Nyíri, 2004) Therefore this age-class prefers diversified relations based on mutual cooperation instead of fixed roles. It takes teachers as experts or mentors; it seeks flexibility and diversity also in the educational sites, devices and calling for account. (Brown, 2005) PUS also built this age-class specific need and the critics raised against the Deficit model in its methodology; its second model already considers that the meeting of science an publicity takes place embedded in everyday situations, socio-cultural and technological environment, thus also the scientific interest of laymen takes is aligned to the entirety of the problems related to finding guidance in the world. According to the *Context model* the head of people is full of strategies for obtaining knowledge; primarily they do not seek general education, but need scientific expertise in exact situations requiring decision. (Gregory & Miller, 1998:88) According to this approach the aim of education is to establish common forum for scientific and everyday interests, i.e. building out high quality and up-to-date relation between the science being prepared – and not only in terms of schoolbooks – and the youngsters. (Pintér, 2015) According to Hamza & Wickman the learning in science need to be approached more as a

⁹ According to the basic theory of *pedagogical constructivism* students learn that knowledge easier in what they are directly involved, what is tangible for them, with what they meet in living situation. (Nahalka, 2002)

contingent process than as something that progresses along one particular dimension. They show *“how students appropriate the sociocultural tools of science and how they situate what they learn in both the particular features of the activity and in the relevant science.”* (Hamza & Wickman, 2013:113) The below table shows a summary of the differences between the traditional learning and teaching paradigm and the two science communication models. (Brown, 2005: 12.6)

Table 2 - Differences between the Traditional Learning and Teaching Paradigm

Traditional teaching	Teaching of generation Z
based on Deficit model	based on Context model
memorising	understanding
recall	discovery
universal, fits for everyone	customised, rich in possibilities
repetition	transfer and creation
learning of isolated facts	facts + systematised conceptual framework
teacher = master, the source of knowledge	teacher = mentor, expert
fixed roles	mobile, changing roles
fixed classroom	mobile, transformable classroom
localised site of teaching	different sites of teaching
summative evaluation	summative and formative

As it is shown in the above table science communication must be an ongoing reconciliatory process, and teacher must give up on one-direction information transfer and the idea that they have no other task than fill empty heads. (Gregory & Miller, 2006:199) If we also add that through their impact on the life of publicity the results of science are becoming more and more social, it becomes understandable that it is vital for the pedagogues to adjust to the requirements of laymen and they should openly face the possibilities of science communication and its practical limits. Accordingly information must be intermediated to generation Z on routes, which take the social and technological factors and the knowledge the students originally possess into account.¹⁰ (Gregory& Miller, 2006:203)

¹⁰ *The Lay Expertise Model* of science communication is built on this idea; it supposes that the existing practical knowledge is at least of the same importance as the theoretical scientific knowledge. (Lewenstein, 2003) According to the scheme there are experts also in excess of scientists and teachers; e.g. on the field of info-

According to this study science communication is able to promote the undertakings of laymen in the disputes in course on the field of science or in political decision-making related to science, only in case it is customised to the generation and embedded in context.¹¹ Although generation Z primarily has no demand for engagement in respect of public life, but in respect of education, raising interest of its members towards scientific news and disciplinary literature is the most important task of pedagogy. As science consumption of the net-generation is more pragmatic than that of the former generation, in addition the socialisation of the “*digital immigrant*” teachers and the “*digital native*” students resulted in different view of world, therefore it is reasonable to see education as a mutual recognition process; as a dynamic exchange-mechanism, in what social groups of different attitudes and different needs take part. (Gregory & Miller, 2006:203) In this dialogue confidence and trust are key factors (Smetana et al., 2016: 89), and in order to this all age-classes must be open, ready to assist and compromise with the different generations. Progressive education can hardly be implemented through authoritarian statements of facts, declarative transfer of knowledge and punitive call for accounting. (Gregory & Miller, 2006:204)

Tasks to be completed in order to establish a progressive education system

As the research findings summarised in this study show, the educational and scientific institutes must examine how they can adjust to the changing demands of the generation and their customer behaviour. (Duga, 2013) Science communication conducted with the digital generation can be successful only in case it builds – besides exploiting the technology – on flexibility in time and space, teamwork, diversity and the already existing knowledge and activity of students. (Harlick & Halleran, 2015) In order to make education progressive it is vital that the teachers and students shall set up partnership, what is based on respect shown for each other, to facilitate placement of competency-based approaches in the forefront against the content-based approaches. (Duga, 2013)

While the traditional model apostrophes learning as a work done with sweat and along facts and curriculum fixed to rules, obtained according to strict time-table, the progressive learning environment provides the experience of integration of knowledge elements gained from diversified sources. (Harlick, 2015) It presents obtaining information as an interesting venture; it inspires setting up internal rules instead of following external ones. (Komenczi, 2009:2) A system successfully serving the education of generation Z prefers project-based development gained in free time frame. Instead of conformism it builds on individual creativity, self-criticism and innovation. Students do not meet up the requirements of teachers, but standards set up based on different disciplinary standpoints (Anderson, 2011: 126), while the work is carried out in smaller groups of heterogeneous composition, in what the older generation is adult, and successfully motivates the creation of the ability of lifelong learning.

communication the members of generation Z can rather be considered experts than the pedagogues belonging to generation X or Y.

¹¹ This process is described in more details in *Public Engagement of Science model*. (Lewenstein, 2003)

Response to the question how such learning environment can be established among the traditional schools is given by the so-called *emphasis-transfer model*, which says that the desired learning environment of information society can also be approached by contrapositioning the characteristics of traditional environment organisation, built primarily on instructions and one-direction knowledge transfer, and the characteristics of the progressive, rather constructivist one. Naturally, the statements in the below table are not contrapositions excluding, but supplementing each other, which serve to show in what direction should the current education system move on in order to suitably serve the demands of generation Z. (Komenczi, 2009:2)

Table 3 – The Differences between Traditional Learning Environment and Progressive Learning Environment

Traditional Learning Environment	Progressive Learning Environment
Teaching of facts, rules and ready solutions	Establishment of skills, competencies and attitudes
Transfer of closed and ready knowledge	Establishment of ability for lifelong learning
The source of knowledge is the school, teacher and the curriculum	Integration of knowledge elements gained from different sources and perspectives
Dominance of teacher's instruction during obtaining knowledge	The student build his knowledge individually in an inspiring learning environment
Fixed curriculum, strict time-table	Project-based learning, free timeframes
Learning is a tiring work	Learning is an interesting venture
Learning in a classroom	Learning at diversified sites
Learning in a class	Learning in smaller, altering groups
Teaching in homogeneous age-class	Learning in heterogeneous age-class
Learning groups within the school	Learning groups between schools
Adaption, conformism	creativity, critics and innovation
Due observance of external rules	Establishment of internal rule
Compliance to teachers	Compliance to standards
Closed, linear, mono-medial learning environment	Open, multi- and hyper-medial learning environment

Implementation of the methodology summarised in the above table requires application of the technology what is able to fulfil the device requirement of progressive learning environment. Within this scope several solutions, customised for the characteristics of generation Z, might get role from the interactive boards through the so-called *Learning Management* (LMS) technologies, through e-Learning framework systems and multi-user educational games to smart phones (MLearning) (Brown, 2005) In education it is necessary to provide space in growing proportion for those different web 2.0 applications, which are used by the students already in their free time: besides multimedia, information and video sharing sites (YouTube, Flickr, Google), social sites (Facebook, LinkedIn, MySpace), virtual worlds (River City, Atlantis, Whyville, etc.) and multi-player games (Rich Man Game, ChangeMaster, Quest Ardene, etc.) are vital to be built in the course of education in the 2010s. Furthermore Olympiou and Zacharia pointed out that experimenting with blended combinations of Physical Manipulatives (PM) and Virtual Manipulatives can be able to enhance students' conceptual understanding in the domain of various scientific topics more than the use PM and VM alone. (Olympiou & Zacharia, 2011:38)

If traditional teaching and curriculum is combined with innovative teaching methods, multimedia elements and modern devices that facilitate an interactive, flexible learning process involving several sensual organs. (Molnár, 2007) Because of experimental lust, target and success-oriented approach and strong network dependence it is important that the institutions shall provide rooms suitable for work in ethnically diversified small teams. Since youngsters are pragmatic and inductive information processors, it is worth to provide them media promoting cooperation, where they can gather knowledge from several sources, by the use of integrated devices and in the course of training-like situations. This, besides charming and challenging materials needs analysing, and presentation applications, divided screens, databases, programs necessary for editing multimedia and access to online helper. (Brown, 2005) Thus adaption of the everyday education activity to the technical environment would make the curriculum not only more interesting and easier to follow up, but it would enhance the learning lust and success of the students.

Naturally, besides transformation of the environment pedagogues expert in information-communication technologies are also vital. Since the knowledge, attitudes and skills of the net-generation is expressly limited by the current educational system, paradigmatic alterations would be necessary also in the preparation of the pedagogues.¹² Collaborative, problem- and project-based education (Pease & Kuhn, 2010) requires new type of teachers, special facilitators, who – in excess of their disciplinary knowledge – possess high level knowledge on information-technological knowledge and competency. (Roberts, 2005) Teachers of 2010s must be able to actively involve and apply in teaching those modern technologies, what are used by their primary target group. If implementation of this fails the members of the young generation shall lose interest in education, and will use the internet

¹² In 2013 Menco Platform carried out a research by involvement of 100 Western European and American pedagogues, and it resulted in that also the pedagogues are open to modernisation of teaching, a significant number of them is interested in application of online devices for teaching purposes. (Menco Platform, 2013)

for other activities, what they consider as interesting and what brings joy to them. (Duga, 2013)

Summary: Are these sociological problems or pedagogical possibilities?

In this article I attempted to give detailed presentation of those changes what has taken place in the socialisation, world view, skills and media usage of generation Z due to the development of info-communication technologies. I was reasoning on behalf of that this multi-dimensional transformation raises not only generation gaps, sociological and pedagogical problems, but at the same time it creates possibility for an educational reform leading to transfer of knowledge, what is up-to-date, customised to the demands of the youngest ones and promotes integration into labour market effectively.

Consequently, renewal of education is only an umpteenth step: technology and service provision planning should be preceded by an action- and intervention-focused society and child-image, what has definite and normative ideas originating from internal initiations about how and in what direction it wants to form the conditions defining science society. (Z. Karvalics, 2013) In order to achieve this it is inevitable to paradigmatically change the approach related to generational discrepancies. According to *Jukes* we are unable to understand and evaluate those stages of development, which the digital natives took during developing their skills. Instead of this we are lamenting over what skills they do not possess. Since digital language is not our native language, and since we appear in their world as digital immigrants, we unconsciously misesteem those children who practice different forms of action than we do; and this negligence prevents exploitation of the social potential hidden in them. (Jukes & Dosaj, 2006)

However this study did not declared to deal this issue, yet it is important to emphasize that information environment aware management must firstly appear on the level of disciplinary policy, what shall - as a complex "pre-reforming" strategic package - create future possibility for the members of the generation growing up through digital culture to become a full value member of the community also in their person. Consequently a science communication paradigm shift discussed in this article is a very complex process taking long in time and space: thus there will be schools shoving information society features in several elements, while in other countries and schools industrial era will still rule. (B. Tier, 2014) The education system is set up from several factors; accordingly considering reform we can only talk about slow distortion of ratios, what is preceded by experiments. However, if a kind of structural and methodological change can be successfully implemented in education, the members of generation Z will spent a part of their free time after school also for self-development, moreover they will do that in way unnoticeable for them, since they will engage themselves in exactly the same activities what they do in their everyday obligatory activities.¹³

¹³ Formation of educational models is also inevitable because the first global digital generation will enter the labour market in a couple of years. Although in the article I did not discuss the members of generation Z as employees, decisions on modernisation of school lessons would be worth to think over by the methodology

One of the key factors of a possible structural and methodological change is to reconsider the current accountability policy. According to Anderson the actual one does not meet the aims and needs of a reform, so he strongly suggest that education leaders and policy makers *“need to evaluate whether or not accountability policies inspire teachers and students in science, foster innovation, and increase teachers’ ability to use research-based practise.”* (Anderson, 2011:125) He points out that *“accountability testing in science should place more emphasis on skills and scientific reasoning found in instructional methods such as inquiry and active learning.* Furthermore accountability systems should use *“multiple measures of students’ ability, connecting to creativity , and students enjoyment of learning.”* (Anderson, 2011:125)

Thus, concentrating on media consumption, characteristics and world view features of the generation, I am also urging the setting-up of a science communication methodology, which, based on the *Context model of Public Understanding of Science*, facilitates cooperation between digital immigrants and digital natives, what is collaborative, project-based, customised, adapting to changes of the world and rich in possibilities and interactions. This requires the establishment of progressive learning environment, and that pedagogues shall review their function and preparedness so that they can participate in information transfer rather as experts or mentors than along fixed pre-defined roles.

The most significant philosopher of China, *Confucius* (551-479B.C.) says *“if I hear it, I forget it; if I see it, I remember it; if I do it myself, I understand it.”* Accordingly, the demands and interest of generation Z can be met only by an educational strategy built on flexibility in time and space (McWilliam, 2015), teamwork and the existing knowledge of the age-class, this way it would be worth if curriculum developers and science managers placed competency-based and pragmatic approaches in the forefront instead of traditional, content-based, theoretical approaches. A precondition to this is that the state shall assure access for each and every member of generation Z to the necessary information technology, what is a definitive step to bridge the social gap dividing the younger generation; to provide equal chances for the richer and less privileged layers.

Although the section did not analyse the limits of cognitive skills of generation Z, mapping them is also vital in respect of social problems and conflicts between age-classes. Recently several – and at first sight frightening – socio-psychological results were derived from research, which prove the harmful impact of technology in the human relationships and cognitive skills of the ones born at the end of 1990s. (Pintér, 2013b) Therefore there will be plenty of professional challenges in the future, but we cannot delay too much with modernisation of the science communication process, since within a couple of years the knowledge of our children – as they will become future employees, decision-makers, voters,

developers also in respect of that the presence of the ones born at the end of 1990s will obviously influence life at workplaces as well. Since this age-class becoming adult, will cause changes not only in the company systems, it will be not enough to be prepared to accept the future “dotcom” adults only on behalf of the organisations, but also the pedagogues should align the content of the curriculum, the requirements and forms of call for accounting to the expectations of the labour market.

and teachers of the forthcoming generation Alpha – will be the main drive of the development of the society.

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