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Is there a difference in the education of generations across time?

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Abstract: An interesting reading tends to be a summary of the dominant characteristics of each generation, which can be found in scientific and vocational publications as well as in media with popularization texts. Very often, we also identify among them our own characteristics and qualities, or those of our peers, children, and possibly other descendants. It is natural that the development of science and technology has a significant role in shaping the personality profile of the members of each generation during the historical development of society (for example, from the "lost" generation to the "alpha" generation). This factor influences the content, methodological and didactic aspects of the teaching process, i.e. what and how to teach. The authors of the paper have worked on several aspects of the preparation of teaching materials and their use in school physics, often with overlap with other science subjects. One of these aspects is, for example, the need to influence the emotional side of the student in learning processes, which is an important prerequisite for more permanent "inscriptions" of information in the student's memory. For this process to work, knowledge of the dominant characteristics of the target group of students and the environment in which they grow up is essential.

1. Introduction

In the past, referring to generations by different adjectives was not very common. Occasionally there were labels such as "*Husák's children*", millennials, or the more familiar "*Lost generation*". But these were rather isolated cases. It is interesting to read the summaries of the dominant characteristics of the different generations that can be found in scientific and professional publications and in the media with popularisation texts. Very often we also identify among them our own characteristics and traits, or those of our peers, children, and possibly next descendants. The issue of generational differences and the related reflection on the need for a change of approach in education began to emerge a few years ago, but nowadays we can no longer speak of a need, but of a necessity.

It is standard for each generation to have comments and reservations about the younger generation, stating 'they are completely different from what we were'. Is this just due to a misunderstanding of the younger generation, an idealisation of their own youth, or is it really so? The answer can be found by examining individual generations, their characteristics, preferences, and attitudes.

If we start deeper in history, we can start with "*The Lost Generation*". I don't think anyone needs to be introduced to this generation, but if there is still a problem with identification, the names Hemingway, Remarque will clarify everything. We will skip a couple of generations and continue with the generation named *Generation X*, or "*Husák's Children*". This is the generation of people born between 1965 and 1979. The generation that started out with a conventional telephone set and considered the switch to the push-button telephone to be a great progress. It is a generation of people who have had the opportunity to follow the development of computers/digital technologies from the beginning and their gradual incorporation, in addition to everyday life, into the teaching process, albeit in their school years only in the form of word processing or numbers. *Generation Y* dates back to the years of birth 1980-1995. The basic feature of this generation is a positive attitude towards media and digital technologies, which have started to enter different areas of life [1]. People born between 1980 – 1999 are also referred to as "*Millennials*". Mostly members of *Generation Y* are represented in this group, but to a lesser extent members of *Generation Z* are also represented.

2. What are the children we educate

2.1 Generation Z (Gen Z)

Generation Y is followed by *Generation Z*, which refers to individuals born between 1996 and 2009. This is a generation that has not experienced a period without digital technology and the Internet, but paradoxically, this does not mean that individuals cannot be digitally illiterate [2]. *Generation Z* is quite different from previous generations "X" and "Y" and is the most technologically advanced yet.
To understand this generation, we need to remember that they have grown up in an era of booming digital technology, the Internet, and social media. This generation has come to terms with modern technology. They know how to switch seamlessly between the virtual and real worlds. They are no longer just users of the Internet, but often create its content themselves [3]. It is not at all difficult for *Generation Z* people to practise multitasking. On the other hand, the overconfidence often bordering on arrogance gets *Generation Z* representatives into trouble when they think they know everything, have heard everything, and have seen everything. They are mainly used to electronic communication. Face-to-face encounters, overwhelmingly, are not their forte.
Other characteristics of *Generation Z* include [4]:

- active use of modern technologies,
- building social contacts and relationships through social media,
- teamwork - with peers - often at a distance,
- multitasking - managing multiple tasks at once,
- having fun and working at the same time,
- the need for independence – wanting independence but at the same time not knowing how to act on their own,
- sharing their thoughts and opinions with the world – loss of privacy, life on the Internet,
- lack of basic skills and experience.

Within *Generation Z*, we also identify the *Generation Alpha* (those born after 2001). This is a generation whose name refers to originality and individuality. Representatives of this generation are described by some writers as overly sensitive and self-centred. They openly talk about a generation of rebels for whom nothing is good enough, they are not satisfied with anything and like to criticise everything [5].

2.2 Generation Alfa

The group of people born after 2010 is referred to as *Generation Alpha*. They don't recognize the world before the technology boom that brought computers, the Internet, game consoles, Wi-Fi, cell phones and digital media. It is predicted that the 'Alpha' generation will become totally immersed in the use of technology and will no longer be able to imagine their lives without it. Unlike previous generations who were merely technology users, members of this generation are likely to trade 'traditional' for global and technological knowledge. This new generation will not think of technology as a tool; they will integrate technology in extraordinary ways into their lives [6].

3. And yet they are different

Across generations, young people from any group have many traits/opinions/attitudes in common, yet members of Gen Z or Gen Alpha are truly different than those of older generations.
Gen Z and Gen Alpha were both born in the era of computers and the internet, they don't remember a world without them, and digital technology has become an integral part of their everyday lives. The mobile phone is the first thing the representatives of these generations turn to as soon as they wake up, and they fall asleep with it as well. Digital technology is no longer a novelty that motivates, but a normal part of their lives that they cannot give up so easily. The second common feature of these generations is multitasking – solving multiple tasks at once, but also quickly and easily establishing relationships (especially virtual ones) and working in a team. Another phenomenon that is inherent in them is social networks and sharing their lives with the world through them. Instead of reading a text, they prefer to watch a video on YouTube. They hardly know libraries; they look for the information they need on Google.
As can be seen from the above, Gen Z and Gen Alpha will need a different approach to be able to keep their attention and motivate them to be active in the classroom. As it is not yet possible to reliably identify the needs and preferences of this generation, we will focus on Gen Z in the following sections. Rothman [7] identified several conditions/requirements for actively engaging Gen Z in the classroom:

- They prefer to convey content quickly through complex graphics. This is a generation that prefers hands-on activities to long explanatory text.
- Clicking between tasks/activities causes short attention spans. They find it harder to learn, lose attention easily and immediately move on to another activity. For this reason, the learning process needs to be done in small steps.
- Gen Z members learn more effectively if they solve problem-solving tasks and use trial and error to find a solution. Playing different virtual games teaches them to solve different problem situations, the solution of which is the key to progress to the next level.
- Gen Z must learn to discover and manage information. They need to focus on critical thinking and problem solving rather than memorization.
- Gen Z prefer to work in teams/small groups.

In addition, we should remember that digital technologies are a necessity for these generations, so it is advisable to incorporate these technologies into the classroom and not to forget the use of social media. Gen Z also prefer online learning materials as well as online testing [8].

4. How to teach them

It is already clear from the characteristics of Gen Z that classroom instruction will not be of much interest to students of this generation. Gen Z needs quick information, lots of action, sequential steps, teamwork, and digital technology should be at everything.
If we want to engage and motivate Gen Z representatives, it is advisable to accept these conditions and to adapt the methods and forms of teaching and, of course, the teaching materials to them. One of the dominant requirements that we must also be considered in the development of teaching materials is to act (in the learning process) also on the student's emotional level. Nowadays, in addition to innovative methods and forms of work, the emotional aspect of education is increasingly being discussed. Learning something new does not only affect the cognitive sphere, but also significantly affects the emotional side of students [9]. According to Mačajová [10, p. 25], "*The greatest chance for learning to be retained, understood, and remembered is to create an environment in which learning produces*

enjoyment." This creates the prerequisite of arousing a more significant cognitive interest in the learner as well as creating more lasting memory impressions.
Based on personal experience, we can say that if we look at it from the point of view of teaching physics, where the experiment plays a key role, we can approach or "get" to the emotional level of the student in a few ways:

- By knowing the environment (and the level of its technical equipment) in which a given generation lives, we can select for the needs of teaching usually simple technical devices, or we can create teaching aids that are close to the students in terms of their use or interest. When experimenting with such aids to explain the application of physics laws in practice, we use, as far as possible, in individual experimental set-ups, the simple elements and devices available, the functionality of which the students become familiar with very quickly.
- The focus is on explaining phenomena from everyday life that students have experience of and explaining them through experimental activities. The activities start with the motivational part, whether in the form of a problem question/task, a description of a real situation, etc. The motivational part acts to arouse the cognitive interest of the students.
- By setting rules for the students for inquiring, by working in small groups – a proven method to engage students.

Inquiry-based activities using digital technologies meet almost all of the conditions expressed above. When used correctly in the classroom, we can achieve, in addition to the educational goal, a positive working environment where we can increase the activity of the students, but also the joy of discovery. However, we must remember that digital technology can no longer be considered a significant motivating factor. With a technological generation like Gen Z, other factors are crucial.

5. Inquiry-based activities and Gen Z

Inquiry-based activities are not new in physics education. Their positive impact on students' learning outcomes has been confirmed several times [11] [12] [13]. Recently, space has also been devoted to the need/effect of acting on the student's emotional side in learning processes, which is an important prerequisite for more permanent "inscriptions" of information in the student's memory [14].
A characteristic element of inquiry-based activities is, among other things, the development of the student's ability to conduct scientific inquiry, which includes identifying and asking research questions, planning, and designing experiments, and collecting, using, and linking the data (evidence) obtained to explanations. We have also adapted the structure of the working materials for conducting this type of activity to this. In all activities, we always emphasised the motivational (introductory) part by which the student is introduced with a realistic model situation inducing a physics problem. Then follow the next steps, which depend on the student's degree of independence in the implementation of the inquiry-based activities (from guided inquiring to open inquiring).
In the following section we give some examples of activities developed in this way at the workplace of the authors of the paper.

5.1 Sample activities for open inquiring

Within the Chain Reaction project (http://www.chreact.umb.sk/), together with the project partners, we have developed materials for open inquiry-based activities for secondary schools (figure 1). The ideas for the activities were based on themes proven in practice, which we innovated and adapted to our needs. The character of most of these activities required the application of cross-curricular relationships, reflecting the fact that science does not work in isolation, but that it is important to use knowledge from different fields to solve different scientific problems. This is reflected in the titles of the activities created: (1) *Collision Course*, (2) *Green Light*, (3) *Portable Hydroelectric Power Plant*,

(4) *Feed the World*, (5) *Ozone Conference*, (6) Cosmic Web Site, (7) *Plants in Space*, (8) *Green Heating*.

The suggested inquiry-based activities provided opportunities for students to simulate scientific work, in most cases with opportunities for hands-on experimentation. Students did not get exact instructions on how to work with the activity. Their task was, among other things, to design a sequence of steps to achieve a set goal. As this was an open inquiring and the activities were quite broadly conceived, their implementation required more time than one or two lessons. In spite of the time commitment, the activities developed met with a positive response [15].

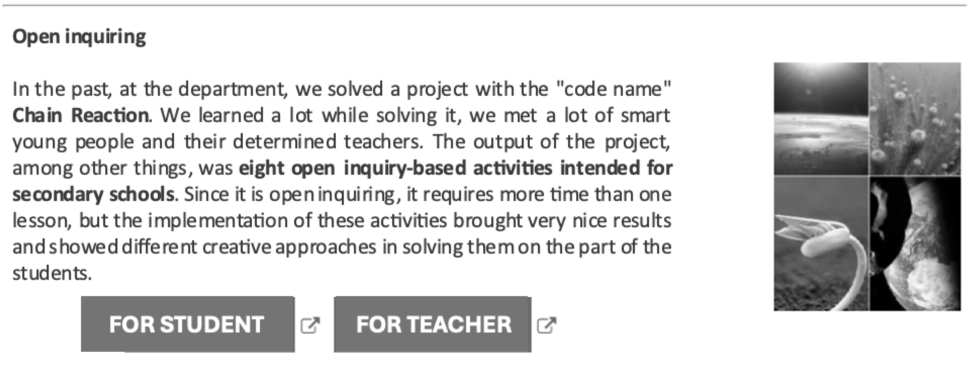

Figure 1. Preview of the website with created inquiry-based activities

5.2 Sample activities for guided inquiring

Another group of inquiry-based activities consists of guided activities, again for secondary school students (figure 2). In contrast to the previous group of activities, in this case the method of implementation) is described in detail, so that students follow a predetermined set of steps for implementation. It is then left to the students to collect and analyse the experimental data. Of course, the motivational part in the introduction cannot be missing.

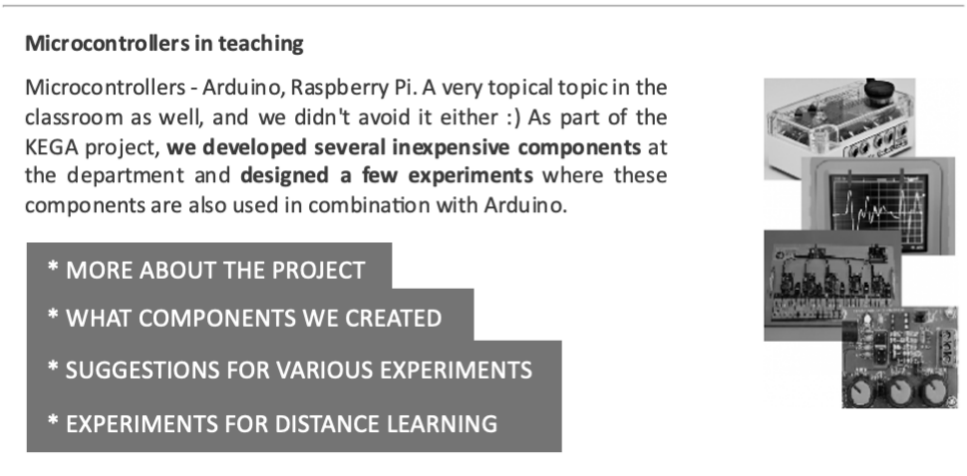

Figure 2. Preview of the website with created inquiry-based activities

Within the framework of these activities a group of "strange" experiments based on technologies commonly available and used today, but which have the potential to surprise and motivate deeper exploration are conducted - the transmission of sound by light (laser, LEDs) – both analogue and digital (analogue to the optical Internet), mechanical modulation of the laser beam (tuning fork, sylon string) – demonstration of one of the possible principles of laser vibrometers, electromagnetic levitator (demonstration of electronic control of the magnetic field of a coil with the corresponding feedback realized by IR light, e.g. elevators, various control or simple control circuits), wireless charging (we searched for and successfully found the simplest way to implement it using school coils), digital sound synthesis, etc.

The specific feature of this group of activities is that the experimentation uses elements of the original experimental set-up that was developed at the authors' workplace. If the activity is used in a school, detailed instructions are available for teachers and, where appropriate, students on how to make the elements of the experimental set-up themselves from available parts. This adds a second dimension to the activities. On the one hand, they can be used as inquiry-based activities in physics classes, on the other hand, they can be used in various seminars where is the place for making the elements of the experimental set-up using knowledge from computer science or technology. This possibility gives the activities a strong cross-curricular character.

Looking at the characteristics of Gen Z, based on our practical experience so far, we can conclude that both sets of activities presented can be interesting for this group of learners:

- the activities deal with everyday life issues that students commonly encounter,
- digital technologies are fully used, and in selected cases, students can even act as constructors of the elements of the experimental set-up,
- the implementation of the activities requires working in groups.

The requirement for quick tasks that do not require long periods of concentration is only met for one group of activities. However, in the open inquiring, students simulate the work of a scientist, exploring, and looking for answers to problem tasks/questions, which could be interesting for Gen Z despite the time complexity of the activities.

As mentioned above, the use of digital technologies during experimental activities is usually not motivating for Gen Z students, as they are literally "ingrained" with technology. However, social media and sharing different moments from their lives are important to many of them. This fact could be leveraged in the implementation of activities if set up appropriately. Students would have the opportunity to share the progress of the activity, their results and conclusions, or feedback on the activity. Of course, there is a risk that the sharing of content on social media will become dominant in the conducting of the activity, and the physics principle, and the obtained results will go by the wayside. The teacher's role in this process will be to manage the students' activities so that these undesirable phenomena do not occur.

6. Conclusion

Generation Z. A uniquely different generation than the previous ones. It is a generation of students who grow up with technology from an early age, and technology many times influences how they function in many ways. Technology is also influencing their behaviour and habits – a reluctance to engage with longer texts, the need for quick and frequently changing information, constant action that needs to be shared on social media right away. In this way, we could go on listing the specifics of this generation for quite a long time.

In educating this generation, we should consider its characteristics, not try to reshape them. Trying to reshape our students would be highly likely to meet with failure and would create unnecessary tension without the desired effect in the educational sphere. This does not mean that the methods, teaching materials, aids used so far are unusable. As an example, we can mention the inquiry-based activities presented above. Although the priority in creating these activities was to respect the elements of inquiring without considering the characteristics of Gen Z, which is currently in the school desks, the activities created appear to be applicable to the current generation of students when they are set up appropriately.

The characteristic of this generation is one thing, but in the educational process, it must always be borne in mind that students are not guided by these characteristics. Each student is an individual who has his/her own needs, and this must be considered when choosing teaching methods, learning materials, and managing the teaching process. If we know the characteristics of a given generation, this can help us, but it is not a one-size-fits-all guide to how to work with that generation in the classroom.

In the context of a generational view of students, it is necessary to prepare future physics teachers but also to educate practising teachers. It is precisely in-service teacher education that needs to be given sufficient space. The specificities of *Generation Z* have taken shape over the last few years and teaching methods and forms should reflect this. In the current KEGA project, it is through student inquiry-based activities in the context of further education activities that we want to convey this perspective to practising teachers. Various workshops will also be carried out within the framework of further education, the aim of which will be to convey the teaching experience directly to practising teachers, as it is they who are confronted with the generations' different approaches to education daily. These activities will result in the establishment of a Physics Teachers' Club (KLUFY), which will aim to systematically develop in-service training activities reflecting current trends and teachers' needs.

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