GAM

# GAM

## RESEARCH PRESENTS

# How much do you know about science?

GAM Research is a part of the Global Awareness Movement. It is an initiative that combines all of our research work in one place. You can find all data, statistics and knowledge we have gathered while working on our projects here. We believe it is extremely important to explore deeply what we are passionate about as it is the best way to learn. This whole process is done in collaboration with experts from different fields, which allows us to maintain professionalism while discovering new things in a creative way.

-Karolina Sosnowska

# What do we know about science?

**Introduction**

Every day we encounter very interesting phenomena in the world around us. Although this one delights us, the phenomena happening next to us seem to be a normal part of our lives, to which we have become accustomed and which we often do not notice. But they are an expression of the perfect laws of physics.

Every day, in a hurry, we pass by indifferently what is happening next to us. Sometimes we will be amazed by the rainbow or the beauty of the sunset. But do you wonder why exactly the sky is blue and the horizon turns red at the end of the day?

If you asked yourself why this happens, you would find the answer why this and no other color dominates the spectrum of light that we see. Perhaps you could answer why the sky is not green.

**What was the survey about?**

In my survey, I wanted not only to get to know the knowledge of respondents, but also to check what part of them is looking for answers to such questions. I noticed that the respondents approached the survey with great enthusiasm. Some people commented that the subject matter raised in the survey interested them, and the survey itself was an interesting entertainment. For others, the questions asked, although they concerned issues taught at school, they could not give the correct answer. It was also surprising that many respondents discussed some phenomena publicly during the survey. On social media or on discussion groups, for example, the subject of the rainbow, blue sky or the issue of planets in the solar system was discussed.

Below I answer the most bothering questions of the respondents, analyze the results of the survey and comment on the statistical data resulting from the survey.

**Basic issues related to the topic of the survey**

In the survey, I decided to examine the knowledge of basic issues of science that accompany us in everyday life and the world around us. The questions asked – they were eleven in total – were related to various phenomena. For example, I asked about our Galaxy, and more specifically about the knowledge of the current scientific consensus regarding the number of planets in the Solar System. Interesting questions concerned optical phenomena such as a rainbow or the color of the sky. I dedicated a few questions to the construction of the atom. And what were the answers?

**How many continents did the survey reach?**

Respondents from 4 continents, i.e. Europe, Asia, North America and Africa, participated in the survey. A group of respondents from Poland was surveyed separately. In total, more than 300 people participated in the survey, 50% of whom were participants from Poland.

Due to the small participation of respondents from some continents, we limited ourselves to comparisons between Poland and the rest of the world. The figure below shows the results obtained by respondents from Poland and the rest of the world.

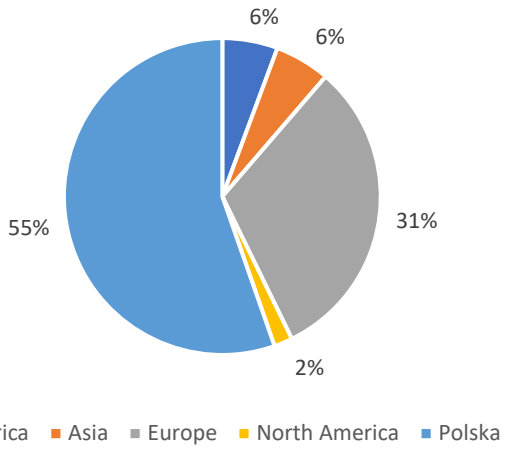



Fig. 1. Origin of respondents to the survey

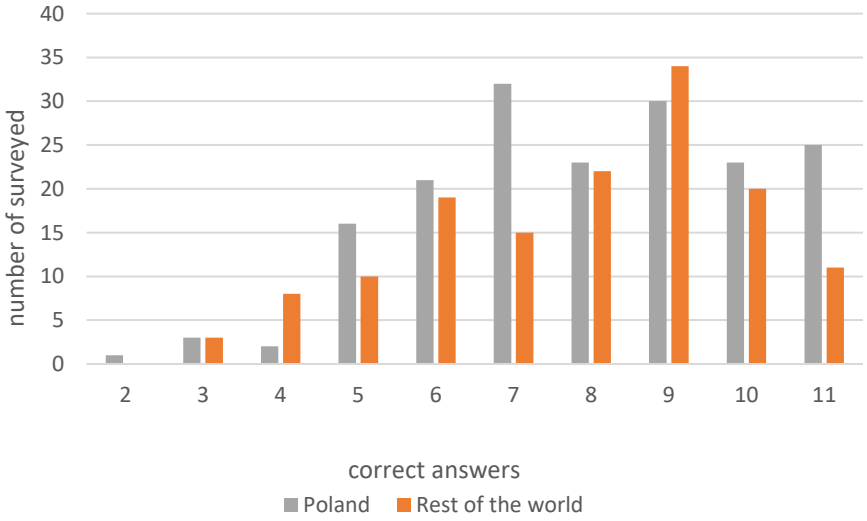



Fig. 2. Number of surveyed to score.

**Who and how answered – Male and Female.**

The participation of women and men was roughly split in half. Their mean response scores were 8.21 for men and 7.61 for women, respectively, out of 11 possible points. After conducting the analysis in the form of a T-test, I obtained a result indicating that there were no significant statistical differences between these two groups.

However, what can be seen in the attached chart is the fact that the highest results from the test were obtained by men. This may indicate their greater/better perception of physical phenomena than women. What's more, the results in individual questions indicated a better perception of men in explaining such physical phenomena as the rainbow, the color of the sky, as well as in the case of the Doppler effect or the structure of the atomic nucleus.

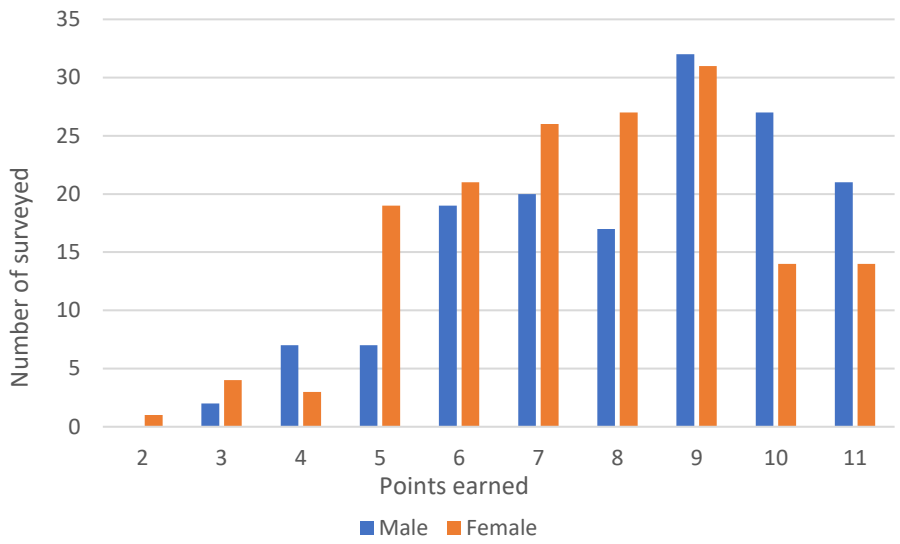



Fig. 3 Number of surveyed to points earned.

**What did the age of the respondents look like?**

Analyzing the composition of respondents participating in the study, it is easy to notice that a fairly even distribution was obtained when it comes to the age of the respondents. This can be seen in the chart below:

Further analysis allows us to look at how the knowledge of basic science issues is shaped in individual age groups, which may have a direct relationship with both education and various levels and intellectual activity in later life.

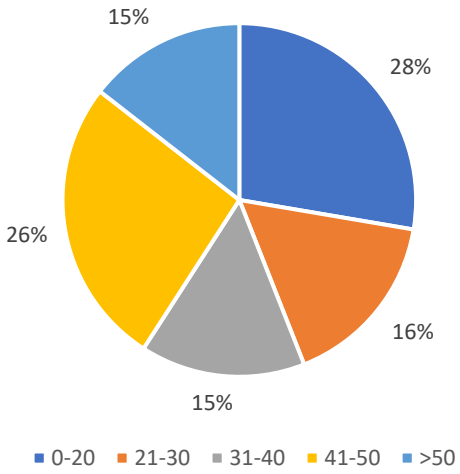



Fig. 4 Age distribution of respondents participating in the survey

The obtained results also allow to trace the level of knowledge resulting from the past education of respondents and to determine how this knowledge - in Poland - compares to the level of knowledge in other parts of the world. Although the number of respondents from North America, Asia and Africa is relatively small, it can be treated as a kind of combined data.

The results obtained in each age group were at a similar level with a slight advantage for Poland. This confirms the high level of education in our country. General education in Poland is apparently still at a high level, if we compare Polish pupils and students against the background of peers from other parts of the world. It looks different in the professionally active group, i.e. 31-40 years old, where the results of respondents from Poland fall, but are still better. For respondents aged 41-50, the result is identical for both groups. Again, the results for respondents 50 years old or more are higher for Poland, despite the fact that we have the right to assume that they were academics with scientific background both in Poland and abroad.

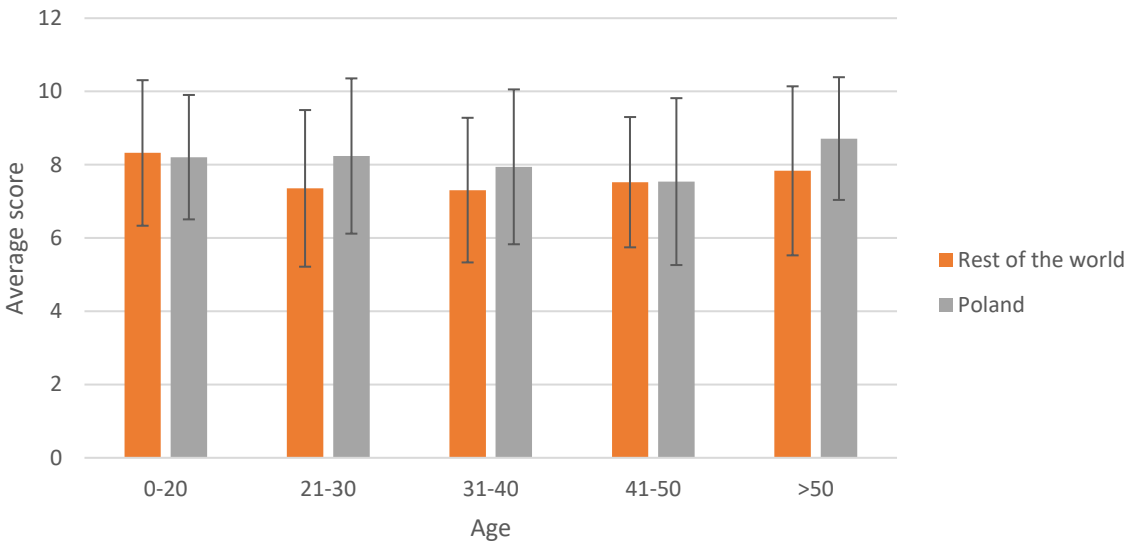



Fig. 5. Average score in individual age groups (Poland, rest of the world)

The result above puts Polish education and Polish society in a good light in the context of knowledge of physical phenomena. It would be good if such a result was confirmed by Polish scientist in their scientific adventures and the outcomes of their work and invented solutions for our planet well-being.

**So, what was this survey about? Overview of selected questions and answers**

**The question about the greenhouse effect received the most correct answers.** As many as 94% of respondents [Fig. 6.] knew that it was caused by the release of carbon dioxide and methane into the atmosphere. Only 5.6% gave the incorrect answer that the greenhouse effect is caused by water waste (0.9%) or higher solar temperature (4.7%).

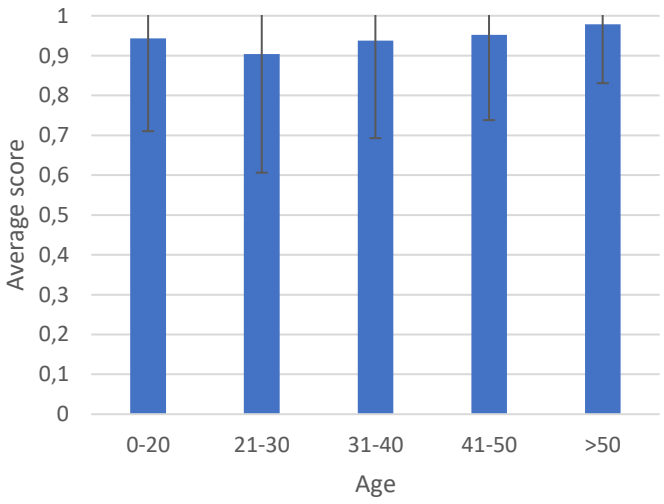



Fig.6 Distribution of correct answers to the question concerning the greenhouse effect in individual age groups

Such a high result of global public awareness proves that the current problem of global warming, which as one of the aspects of the future of our planet - is sufficiently explored in the media and education. The authors of other studies come to similar conclusions, indicating how much awareness of the global community is[1] in this important problem of global warming, which poses a big threat to the world around us.

[1] M. Fagan, Ch. Huang, *A look at how people around the world view climate change,* https://www.pewresearch.org/fact-tank/2019/04/18/a-look-at-how-people-around-the-world-view-climate-change/), 05.01.2023.

**What question received the least correct answers?**

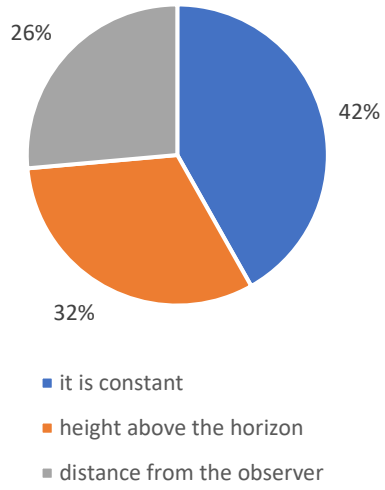
Without a doubt, the rainbow belongs to spectacular optical phenomena. But do we wonder what causes it? Why do we never see it from the side? Where exactly does it start and end?

Through the optical illusion, the rainbow appears to be a colored flat stripe in the sky that ends behind the horizon. Do we wonder how it is in reality? The results show that not all of us. Respondents answered this question correctly only in 42%.

And yet such perception (flat stripe) of the phenomenon of the rainbow may only be to an optical illusion. When we understand what the play of light is, we realize that our perception of the rainbow is really about a multidimensional phenomenon.

As a result of diffraction and reflection in water droplets, white sunlight is separated into individual colors. [2]Further this light leaves the droplets, changing its direction by 138-140 degrees (depending on the color). Therefore, we then see colored light, which is arranged in the form of a circle with an angular radius of 42 degrees. Understanding this phenomenon, it is easy to dismiss the wrong answer I gave in the survey, that the angular diameter depends on the distance from the observer. Height above the horizon is also easy to exclude. In the rainbow we have a collection of water droplets that, regardless of distance and height, reflect light in a certain direction.

Fig. 7. The percentage of answers to the question about the rainbow.




Only 41.8% of respondents answered correctly that the angular diameter of the rainbow is constant. As many as 31.8% stated that it depends on the height of the rainbow above the horizon and 26.4% that the angular measure of the rainbow depends on its distance from the observer.

Such poor knowledge of this phenomenon may indicate that it does not find space among people. It would seem, therefore, that the rainbow is not interesting. And yet it delights us and we look for it in the sky. Why, then, do so few of us ask ourselves what a rainbow is, how it arises, or whether it has a beginning and an end?

[2] Diffraction- It is the refraction of light when changing mediums, in this case air-water.

**Why is the sky blue?**

Another question about the world around us, namely "Why is the sky blue?" received a much better result. As many as 74% of respondents answered correctly. This question also concerns the phenomenon we encounter every day. I wanted to check what part of the respondents understand why we see the blue color. I am glad that after the survey many questions appeared on this issue!

This interesting phenomenon can be explained by the behavior of electromagnetic waves in the atmosphere. Light is scattered in the atmosphere by particles – a phenomenon called Rayleigh scattering. This scattering depends on the wavelength of the light. Blue light, with the shortest wavelengths, is scattered in the atmosphere the most - that's why we see it the most. The same phenomenon is responsible for the red sunset, the path of light is longer, so the spectrum is dominated by colors with a longer wavelength – these are yellow and red colors.

This question was correctly answered by 74% of respondents, 11.9% stated that water is reflected in the sky, and 13.8% that gases in the atmosphere are blue colored. The second answer suggesting that water reflects in the sky (incorrect) is related to the popular opinion that the Ocean is blue because it reflects blue sky. However, this is not true, and the blue color is the result of absorbing other colors.[3]

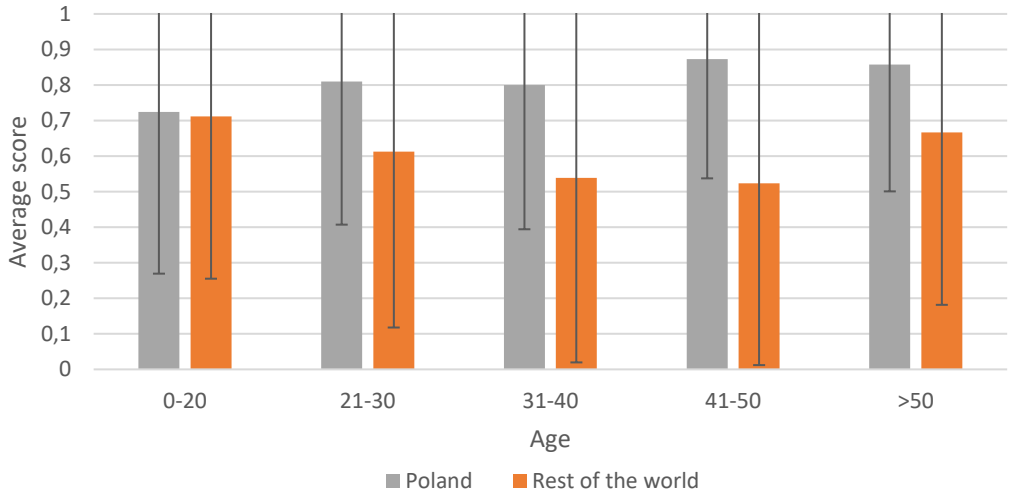



Fig. 8. The percentage of correct answers depending on age.

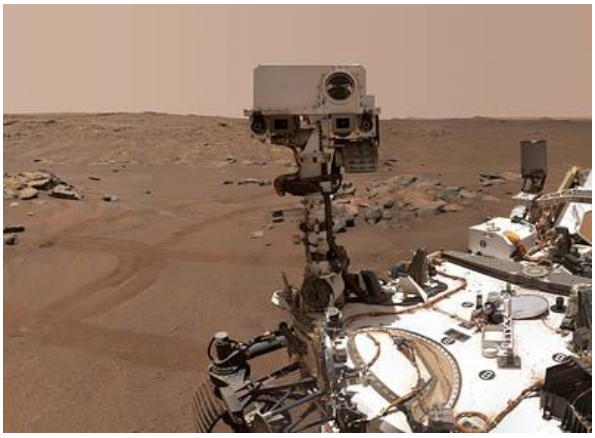
Interestingly, there is a significant difference in the knowledge of this phenomenon in Poland. For some age categories, the difference was over 30% in favor of scores got by Poles aged 41-50. If you explore the topic further, it turns out that the topic of the color of the sky from a physical point of view is very fascinating. For example, the color of the sky during the day on Earth is radically different from the color of the sky on Mars, where it is orange during the day, and becomes cold, gray colors only at sunset.[4]

[3] A. McVean, *"Why? is the Sky Blue?" Or Better Yet, Why is the Ocean Blue?*, (https://www.mcgill.ca/oss/article/environment-general-science-you-asked/why-sky-blue-or-better-yet-why-ocean-blue), 7.01.2023.

[4] *"Why Is the Sky Blue?"*, https://spaceplace.nasa.gov/blue-sky/en/, 05.01.2023

**Why is the color of the sky different on other planets or on the moon?**

In the case of a moon that has no atmosphere, there is no scattering of light, and in many pictures you can see that the sky on the moon is black.
A more interesting and complicated phenomenon occurs on Mars, where blue light is scattered in the atmosphere, but in large part it is absorbed by dust in the atmosphere, resulting in an orange-brown color. [5]

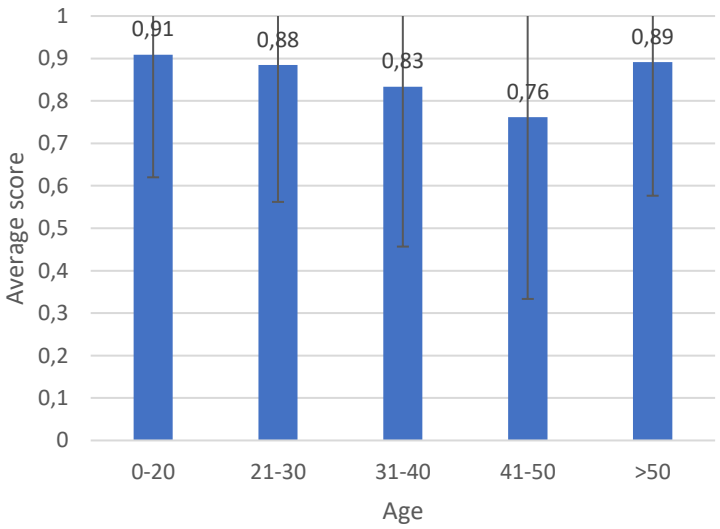


*Mars Exploration Image Gallery*, https://www.nasa.gov/mission_pages/mars/images/index.html, 05.01.2023

**Another seemingly obvious question is** "The Earth orbits the Sun in:? Of the answers obtained, as many as 85% were correct, indicating that the Earth orbits the Sun in 365 days.

With this question, however, it should be noted that as many as 14% of respondents answered that the Earth orbits the Sun in 24 hours. These people indicated the time of rotation of our planet around its axis, which corresponds to the time of day and night. So, they confused two independent phenomena. This mainly concerned people aged 41-50.

Fig.9 Distribution of correct answers to the question "**The Earth orbits the Sun:**" in individual age groups




The annual orbit of the earth around the Sun has many implications in our lives. Why does February has 29 days every 4 years and why do we have seasons? Searching for answers to these questions seems like a simple task, but they cannot be explained without awareness of the movement of the earth. Does this mean that some of the respondents did not wonder why snow falls every 365 days?

[5] E. Siegel, *Ask Ethan: Why Does Mars Have A Bright, Red Sky?*, https://www.forbes.com/Sites/startswithabang/2018/03/17/ask-ethan-why-does-mars-have-a-bright-red-sky/?sh=52881a003453; S. Pérez-Hoyos. *What color is the sky on Mars?*, https://serious-science.org/what-color-is-the-sky-on-mars-7310, 05.01.2023

**How many planets are there?**

The question "how many planets are in the Solar System?" was intended to test people's awareness of the current scientific consensus excluding Pluto from planets. It was excluded from the group of planets of the Solar System, because, according to scientists, it did not meet all the characteristics of the planet, which are: the orbit around the Sun, sufficient mass associated with the spherical form of the planet, and the lack of larger objects in nearby space. Pluto, which meets only the first two conditions, has been considered a dwarf planet since 2006. So, according to the scientific consensus, we currently have 8 planets in the solar system. [6]
Looking at the answers, we can see that almost 2/3 of the respondents answered correctly indicating 8 planets, they excluded Pluto as one of them. Another 27% of responses included Pluto as the 9th planet of the solar system.

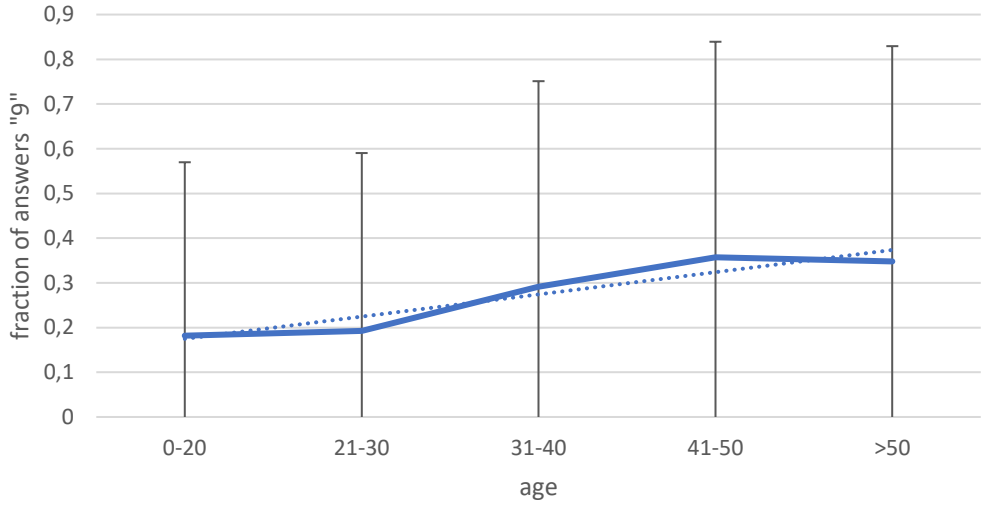



Fig.10 Distribution of answers saying that there are 9 planets.

The above chart illustrates well the lack of update of knowledge gained from school education by older people. The vast majority of these people still consider Pluto to be a planet in the solar system. And the number of these answers gives some food for thought. People aged 41-50 (36% of wrong answers) as much as twice! were more likely to give the wrong answer than people aged 10-30 (18% of wrong answers).

[6] *Why is Pluto no longer a planet?*, https://www.loc.gov/everyday-mysteries/astronomy/item/why-is-pluto-no-longer-a-planet/, 6.01.2023.

**What is going on in a nuclear power plant?**

The subject of nuclear energy concerned the phenomenon releasing energy in nuclear power plants. Respondents were asked to indicate whether the source was combustion, fission or fusion of the nucleus. This question was correctly answered by 75.8% of respondents, indicating that the reason is nuclear fission. An interesting observation is that not only is the percentage of correct answers quite high, but the average result of answers given by respondents in Poland and the rest of the world is identical for people over 30 years old. This means a globally unified awareness of this phenomenon and indicates that the problem of nuclear energy is very widely known to people of this age.

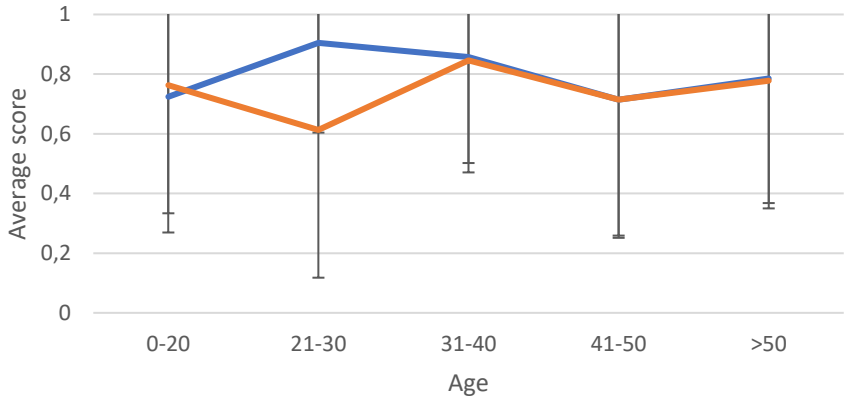



Fig. 11. Distribution of correct answers to the question "**In nuclear power plants the energy originates from:**" in individual age groups.

In the 21-30 age category, Poles answered much more often correctly than respondents in other parts of the world. As many as 90% of the answers given in Poland were correct, compared to 61% of correct answers in other parts of the world. As you can see, the currently vivid issue of the construction of nuclear power plants in Poland resulted in the popularization of this issue and discussion among this age group, allowing them to have appropriate knowledge in the subject of nuclear energy.

# Conclusions:

I am glad that the survey made the participants want to ask questions. Taking into account the subsequent discussions on social media of the same respondents, I am inclined to the conclusion that the wrong answers may in some cases have been given spontaneously, without second thought. However, it is impossible not to draw the conclusion that in such seemingly basic issues (such as: the movement of the Earth around its axis) inattention rather indicates forgetfulness and not paying attention to the physical aspects of the world around us.

**What make us interested?**

We are interested in complex phenomena that we eagerly explore. A large part of the respondents is able to determine what reaction takes place in nuclear power plants, but we often omit interesting things that are at our fingertips. Many of us give up on exploring physical phenomena and a superficial knowledge of them satisfies us.

**When do we forget?**

Superficial knowledge of physical phenomena or inattention of respondents in the 30 plus group indicates forgetting and not paying attention to the physical aspects of the world around us, or insufficient (ineffective) education during the school period, which would allow certain phenomena to continue to remember. We remember things that we understand or that are interesting to us.

**What makes us to know?**

Topics that concern us directly, e.g., the greenhouse effect or the construction of nuclear power plants, and which are publicized in the media by individual interest groups, are definitely better known to respondents. Knowledge in these topics clearly stands out from other groups. Both topics are sufficiently explored in the media in terms of respondents' awareness.

## Postulates:

**When do you find the new idea interesting?**

When observing the respondents' reactions, we come to the conclusion that when we talk about the diversity of physical phenomena (e.g. a different sunset light is on Earth, and another on the Moon or Mars), we begin to wonder and become interested in a new pieces of our surrounding that we have not paid attention to before. It seems, therefore, that in order to popularise knowledge of physical phenomena among the whole community, and in particular among older people, such information should be provided not only on scientific websites, but in publicly available publications.

**How to make school education to overcome the time laps?**

At the stage of school education, knowledge should be transmitted in a practical way. This is due to the fact that respondents aged 30 plus do not remember what they learned at school or, for example, confuse basic concepts (e.g., rotation of the earth around its axis with its rotation around the Sun). Many of them also do not remember the school teaching vividly enough about e.g.: refraction, making it hard to know or remember later why the rainbow exists.

**I would like to thank** Kacper Ścibski for his time, valuable support and constructive comments I received throughout my work on this report.
I would like to thank Mrs. Jola Kulik for disciplining me. And above all, I would like to thank Professor Magdalena Fikus for mentoring and strict but substantive comments that made me work on the report even more effectively.