EKO.LOGICZNI

Script for trainers of adults with low basic skills in the area of mathematics

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Publisher:

Inthinknity Foundation

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81-365 Gdynia

Poland

In collaboration with:

Verein zur Förderung von Beschäftigung u.
Qualifizierung Bad Frw. e.V.

Am Weidendamm 7

16259 Bad Freienwalde, Niemcy

Gdynia 2024

Wydanie pierwsze

The presented publication is an intellectual output of the project **"EkoLOGIKA - developing basic skills for socially excluded adults,"** coordinated by the Inthinknity Foundation, co-funded by the Erasmus+ Program KA2 Small-Scale Partnership Cooperation, project number 2023-1-PL01-KA210-ADU-000159707.

The project partner was the German association Verein zur Förderung von Beschäftigung u. Qualifizierung Bad Frw. e.V.

The publication has been prepared in three language versions – Polish, German, and English.

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Funded by the European Union

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VFBQ Bad Freienwalde e.V.

Contemporary challenges related to the low level of mathematical skills among seniors are becoming increasingly noticeable. In Poland, as in many other developed countries, the aging population means that a growing number of elderly people are struggling with difficulties in counting and mathematical reasoning. This not only limits their ability to use modern technologies but also affects their daily functioning, including managing finances and understanding contracts and documents.

According to research published by the Institute for Educational Research as part of the project "Chance – New Opportunities for Adults," seniors represent one of the key groups in need of educational support to improve their basic skills, including mathematical abilities. Data indicate that older adults are particularly vulnerable to social and technological exclusion due to a lack of mathematical skills, which has become a significant issue in the context of rapidly advancing digitalization.

Basic skills encompass a wide range of competencies that enable active participation in society and the labor market. Among them, mathematical reasoning holds a special place. It is not only the knowledge of numbers and basic mathematical operations but, more importantly, the ability to apply mathematics in everyday life—evaluating offers, understanding financial data, managing a household budget, or using online services such as internet banking.

The low level of mathematical skills among seniors can be attributed to various factors, including education level, work experience, and changes in educational systems. Seniors who completed their education decades ago did not have access to modern methods of teaching mathematics, and their education often focused on basic operations that are insufficient in today's rapidly changing world. Additionally, publications available online indicate that individuals with low education levels are more prone to difficulties in understanding mathematics.

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There are many reasons for the low level of mathematical skills among seniors, including:

- Gaps in formal education: The educational system, especially in the past, did not always place enough emphasis on developing mathematical skills, particularly in practical applications.

- Lack of motivation and opportunities for lifelong learning: Many older individuals ended their education at the primary or secondary school level and never had the chance to continue learning mathematics in a more advanced form.

- The phenomenon of deskilling: Over the years, seniors who have not had the opportunity to practice their mathematical skills may gradually lose previously acquired competencies. This phenomenon, known as deskilling, also applies to other areas, such as digital or language skills.

- Rapid technological development: Digitalization and the increasing complexity of technology require not only computer literacy but also the ability to understand financial data, analyze results, and make informed economic decisions, which often exceed the capabilities of seniors.

Low mathematical skills have a direct impact on the daily lives of seniors. Difficulties in understanding and processing numerical information can lead to problems in managing their finances, making purchases, understanding contracts, and using banking services.

Seniors often encounter difficulties in managing their finances, which can lead to problems with household budgeting. The inability to calculate loan costs, understand bank offers, or interpret bills are just a few of the many negative consequences of low mathematical skills among older adults.

The modern healthcare system requires patients to understand numerical information, such as medication dosages, appointment schedules, or calculating treatment costs. A low level of mathematical skills significantly increases the risk of errors in such a vital area of seniors' lives, namely taking care of their health.

Additionally, seniors with low mathematical skills often struggle to use modern technologies such as online banking or mobile applications. In the digital age, the lack of these skills becomes a significant barrier to accessing basic services and leads to the social exclusion of older adults.

In light of the aforementioned examples of how low mathematical skills impact the daily lives of seniors, it becomes evident that improving basic mathematical skills among seniors is a crucial task for both educational organizations and public institutions. There is a need to develop dedicated educational support programs that address the specific needs of this group. In particular, seniors should have access to both formal education (e.g., math courses) and informal education (e.g., workshops organized by universities of the third age). It is important that educational offerings are tailored to their actual skill levels.

It is also essential to provide technological support for seniors, including the implementation of user-friendly technologies that simplify managing finances and daily tasks, which can significantly improve the quality of life for older adults. Support in using these tools should be an integral part of educational programs.

In summary, the low level of mathematical skills among seniors is a complex issue, with its causes rooted in their educational past, a lack of motivation for lifelong learning, and rapid technological changes. The absence of these skills has serious consequences in daily life, leading to financial difficulties, challenges in accessing healthcare services, and technological exclusion.

Sustainable development is a concept that aims to harmoniously combine economic growth, environmental protection, and social progress to ensure suitable living conditions for both current and future generations. Issues related to sustainable development include conserving natural resources, reducing pollution emissions, supporting renewable energy sources, and minimizing waste. Seniors, as a social group, have a significant impact on the environment. However, research shows that the level of knowledge about sustainable development among seniors is low. Many older adults lack sufficient information about ecology, climate change, and environmental protection. This problem has its roots in educational, social, and technological factors.

Similar to the case of low mathematical skills, the low level of knowledge about sustainable development can be explained by gaps in formal education. During the time when most of today's seniors were receiving their education, issues related to environmental protection and ecology were not yet widely discussed in school curricula.

Ecology as a science and sustainable development have only gained significance in recent decades, primarily due to global climate change and environmental degradation.

As a result, many seniors did not have the opportunity to learn about these topics during their education. Furthermore, adult education programs often overlook aspects of sustainable development, focusing primarily on vocational and technological skills (considered "more useful in everyday life").

Another factor contributing to the low awareness of sustainable development is the overall low ecological awareness in society, especially among older generations. For many seniors who grew up in times when environmental issues were considered marginal, lifestyle changes such as saving energy or reducing plastic consumption may be difficult to understand and accept.

Modern information campaigns often focus on younger social groups, which makes seniors feel excluded from discussions about environmental protection.

In turn, the low level of digital skills among older adults means that seniors use the internet and social media less frequently, which also limits their access to information about current challenges related to climate and the environment.

The phenomenon of deskilling, or the loss of previously acquired skills, also applies to knowledge about sustainable development. Even if seniors had the opportunity to engage with environmental issues in the past, the lack of regular contact with these topics causes them to lose knowledge and competencies. Additionally, the dynamic changes in the field of sustainable development and technologies, such as renewable energy sources, can make seniors feel lost in the "modern world of ecology."

The low level of knowledge about sustainable development among seniors has serious consequences, both for themselves and for society as a whole. A lack of ecological awareness leads to behaviors that can negatively impact the environment and also limit their quality of life.

Seniors who lack knowledge about ecology often make consumer decisions that are not aligned with the principles of sustainable development. For example, they may use disposable products, fail to conserve energy or water, and not separate waste. The absence of these actions not only increases their carbon footprint but also limits potential financial savings that could result from more efficient resource use.

Modern technologies, such as smart energy management systems, solar panels, or electric cars, require a basic understanding of their functioning and environmental benefits. Seniors who do not comprehend these technologies will struggle to implement and use them in their daily lives, making them more vulnerable to being left behind in the mainstream of technological changes.

The low level of knowledge about sustainable development also results in seniors being less likely to engage in environmental protection activities, such as volunteering in ecological organizations or participating in local pro-environmental initiatives, which reduces their civic engagement.

Learning mathematics and ecology can be effectively combined, which will not only improve seniors' numerical skills but also increase their environmental awareness. Applying mathematics to understand issues related to sustainable development can be highly beneficial in seniors' daily lives and help them make more informed decisions

Mathematics is a key tool in understanding issues related to sustainable development. For example, the ability to calculate energy consumption, monitor electricity bills, or analyze carbon emissions can help seniors understand how their daily actions impact the environment.

Teaching seniors simple calculations related to energy savings, calculating water consumption, or analyzing the costs of investing in eco-friendly solutions (e.g., solar panels) can not only improve their mathematical skills but also increase their environmental awareness.

Combining mathematics with ecology in practical tasks can make learning more engaging and useful for seniors. For example, seniors can learn how to calculate savings from using energy-efficient light bulbs or solar panels. They can also learn to calculate how much water can be saved by installing water-saving devices, which will contribute to greater environmental awareness.

Mathematics can also be a tool for analyzing global trends related to climate change. Calculations related to carbon emissions, temperature rise projections, or assessing the impact of human activity on the environment can help seniors understand why changes in their daily habits have a real impact on the planet.

In summary, the modern challenges faced by societies worldwide require integrated actions in education, particularly in the context of the growing need for sustainable development. One of the key areas of this education is raising ecological awareness and improving mathematical skills, which together have great potential to enhance the quality of life, especially among seniors. Older adults, often struggling with limited mathematical skills, also face the challenge of understanding complex ecological concepts.

Therefore, combining these two areas in the education of seniors can bring numerous benefits.

Both mathematics and ecology form the foundation for making informed decisions. Knowledge about sustainable development helps seniors understand how their daily choices can impact future generations, the natural environment, and their own finances. On the other hand, mathematical skills are essential for interpreting data, performing calculations, and conducting analyses, which enable fact-based decision-making. Without these skills, seniors may struggle to manage their resources—both financial and environmental.

In response to the challenges outlined on the previous pages regarding non-formal education for adults with low mathematical skills, particularly seniors, the project "EkoLOGIKA – Developing Basic Skills for Socially Excluded Adults" was created. Its aim was to combine mathematical education with topics related to ecology and sustainable development.

The project focused on developing a comprehensive educational program that seamlessly integrates these two aspects.

As part of the project, we adopted an innovative approach aimed at supporting seniors in acquiring practical mathematical skills that also contribute to a better understanding of environmental issues. Understanding the connection between numbers and the natural environment, as well as the ability to apply this knowledge in everyday life, became a key element of the program. As a result, we present to educators and all interested readers a three-part publication designed not only to support educators but also to enhance seniors' skills in ecology and mathematics.

The result of the project partners' work is a publication consisting of three key sections: the introduction, the main section, and the conclusion. Each part has been designed to provide practical tools for educators working with seniors with low mathematical skills, while simultaneously teaching them a sustainable approach to life.

The first part of the publication is the introduction, where we present the conclusions from the partners' own analysis regarding basic mathematical skills among adult beneficiaries of educational activities. This section explains why many seniors have low mathematical skills and explores the causes behind this issue.

The analysis conducted by the project partners revealed that seniors often face difficulties in daily life due to gaps in mathematical education, such as problems with calculating costs, managing household budgets, or understanding more complex financial matters. This is reflected in the previously mentioned data.

Moreover, the lack of mathematical skills makes seniors less likely to engage in pro-environmental activities, which often require processing numerical data (e.g., calculating savings from recycling or reducing energy consumption).

The introduction aims not only to outline the scope of the problem but also to identify gaps in the knowledge and skills of seniors that can be addressed through well-designed educational programs. The analysis also considers social and technological factors contributing to this issue, such as limited access to digital technologies and the lack of tools that support learning in both mathematics and ecology.

The main section of the publication consists of 12 eco-math workshop scenarios, specifically designed for educators working with adults who have low mathematical skills. The scenarios aim to assist educators in conducting lessons that practically combine the teaching of mathematics with environmental topics.

1. Is water slipping through your fingers?

This workshop focuses on the importance of saving water in daily life, introducing participants to volume calculations and unit conversions. Seniors learn how to calculate the amount of water used during daily activities such as bathing, brushing teeth, or washing dishes. Participants discover how small changes in habits can significantly reduce water consumption, bringing both ecological and financial benefits.

2. Can you pay lower bills?

This workshop emphasizes learning how to calculate percentages and understanding how mathematical skills can help with everyday savings. Participants learn to calculate percentage savings on energy, water, or gas bills by analyzing real-life examples. Together, they estimate how percentage savings can reduce the costs of household appliances, improving not only their mathematical skills but also their economic and environmental awareness. The sessions help participants better understand how everyday consumer decisions affect their expenses.

3. Can you reduce the waste you produce?

This workshop highlights the importance of reducing waste production and teaches participants how to calculate waste volumes based on daily purchases. Seniors learn how to estimate the amount of waste they generate and how small changes, such as choosing bulk products or multi-packaged goods, can help reduce waste. The workshop encourages active thinking about recycling and waste reduction, which are key elements of sustainable development. Participants develop mathematical skills related to estimating and calculating the volume of, for example, waste containers.

4. Do you know how much smog costs?

In this workshop, participants learn how to calculate the costs associated with smog emissions and air pollution. The goal is to raise awareness about the negative impact of pollution on health and the environment. Seniors are taught how to analyze data related to emissions and estimate the healthcare costs of diseases linked to air pollution.

Through these sessions, participants gain the mathematical skills needed to analyze complex numerical data and better understand the impact of smog on daily life.

5. Is switching to vegetarianism "worth it"?

The workshop aims to demonstrate how percentage calculations and cost analysis can help assess the financial viability of switching to a vegetarian diet. Participants learn how to calculate percentage differences in spending on meat-based and vegetarian food and how such changes can affect their budget. The workshop highlights that a plant-based diet can not only lead to savings but also help reduce greenhouse gas emissions. Participants also learn to calculate the difference between a percentage and a percentage point, a key mathematical skill for everyday life.

6. Can you live without plastic

During this workshop, participants learn how to reduce plastic use in their daily lives while developing mathematical skills related to calculating surface area and volume.

The workshop focuses on the problem of excessive plastic use and its impact on the environment. Seniors calculate the volume of plastic packaging and explore alternatives that can reduce the amount of plastic waste produced. The workshop encourages participants to reflect on their own consumption habits and implement simple changes that can contribute to environmental protection.

7. Do you know how much clean air weighs?

This workshop introduces participants to calculating the volume and mass of air, as well as its density, helping them better understand the composition of air and its impact on health. Participants learn how to calculate the volume of air in a room and how to convert units of volume. The workshop aims to develop mathematical skills related to unit conversions and raise awareness about the importance of air quality for health and daily life.

8. Do you know how to create your own compost?

Participants learn how to create their own compost while developing mathematical skills related to calculating proportions and volume. Seniors discover which ingredients are needed for composting and how to calculate their proportions to achieve optimal composting conditions. The workshop aims to raise participants' ecological awareness by promoting composting as a way to reduce waste and improve soil quality.

9. Do you know how quickly it gets hot?

This workshop focuses on analyzing temperatures over different periods and calculating arithmetic means, medians, and modes. Participants learn how these parameters can help assess the rate of temperature increase in a given region. The session teaches how to interpret numerical data related to climate and how changing weather conditions affect daily life. The workshop develops mathematical skills in practical statistical analysis.

10.Do you know what is more likely in nature?

This workshop introduces participants to concepts related to probability, using examples from nature. Seniors learn how to calculate the probability of various natural phenomena, such as rainfall or temperature increases. The workshop develops mathematical skills in data analysis and decision-making based on probability calculations.

11. A drop in the ocean... water resources worldwide?

The workshop aims to raise participants' awareness of the limited nature of water resources on our planet. Through a variety of practical tasks, participants learn about the current state of the world's water resources and the consequences of their mismanagement. The class also places a strong emphasis on developing mathematical skills, including reading and interpreting graph data and analysing water-related statistics. Participants engage in activities to conserve water and better manage this precious resource.

12. Can viruses be counted?

The workshop introduces seniors to the world of mathematics, focusing on the concept of power, which is central to modelling the spread of viruses. The class begins with a discussion of what viruses are, how they spread and how mathematics can help in understanding this process. Participants learn how powers are used to model epidemics, while acquiring calculus skills and recalling the laws of operations on powers. The workshop aims to develop mathematical skills through the practical application of powers in the analysis of phenomena related to the spread of viruses.

Each of the presented workshops combines mathematics with ecology, offering participants practical tools they can apply in their daily lives. The scenarios aim to improve seniors' mathematical skills while emphasizing the importance of sustainable development and environmental protection. The workshops demonstrate that mathematics and ecology can be effectively integrated in education to support seniors in making informed, eco-conscious decisions.

The summary forms the third and final part of the publication, where we present conclusions from the scaling process, highlighting key insights gained from the workshops involving 100 seniors. This section provides practical advice for educators, developed based on experiences and observations from real sessions.

During the scaling process, special attention was given to how different groups of seniors responded to the integrated teaching of mathematics and ecology. It was found that seniors were more eager to engage in learning when they could see the direct benefits of understanding numbers and how these numbers could impact their daily lives—both financially and environmentally.

The summary also addresses the challenges that educators faced during the workshops. It became clear that seniors had varying levels of mathematical skills, requiring educators to take a flexible approach and adjust the pace of learning to meet the individual needs of participants. Some seniors, despite having low mathematical skills, were particularly interested in ecological topics, which naturally facilitated the integration of both areas of learning.

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The guidelines for educators also include best practices for motivating seniors to continue learning and applying the knowledge they gain in practical ways. These conclusions highlight that a key element of success is engaging participants through practical tasks and projects that have direct relevance to their everyday lives.

The publication we present to you is the result of months of work by project teams from Poland and Germany—educators and practitioners who set out to support seniors in learning mathematics and understanding sustainable development. We believe that a comprehensive approach to teaching, which combines both areas, can bring tangible benefits not only in enhancing seniors' numerical skills but also in shaping their conscious pro-ecological attitudes.

By placing this publication in the hands of educators, we hope it will become a valuable tool in their daily work with adults who have low mathematical skills. We aspire for these eco-math workshops to serve as an inspiration for further efforts to raise ecological awareness and numerical skills among seniors, ultimately helping them better navigate an ever-changing world!

INTRODUCTIN

Presentation of Conclusions from the Partners' Own Analysis Regarding Basic Mathematical Skills Among Adult Beneficiaries of Educational Activities

The analysis of mathematical skills among individuals in late adulthood (60+ in Poland and 50+ in Germany) was a key element of the project "EkoLOGIKA – Developing Basic Skills for Socially Excluded Adults." The project was carried out by the Inthinknity Foundation from Poland and the German association Verein zur Förderung von Beschäftigung u. Qualifizierung Bad Freienwalde e.V. The first month of the project (September 2023) was dedicated by the partner organizations to a detailed diagnosis of participants' needs, aimed at gaining a deeper understanding of their mathematical skill levels and the barriers to their development.

The study involved 194 seniors in Poland and 117 seniors in Germany. The analysis was an extension of the initial diagnosis conducted during the preparation of the project funding application. Tests assessing mathematical skills and surveys were used to collect seniors' opinions about their educational needs and the barriers they face in learning mathematics and ecology. The study was further complemented by interviews with adult educators who work with seniors on a daily basis.

Target Group Specifics

The target group for the study included seniors aged 60+ in Poland and 50+ in Germany, with the older age group being surveyed in Poland to reflect the diverse needs and skill levels based on the demographic context of both partner organizations' regular participants (the coordinating organization, Inthinknity Foundation, works with members of a senior club, while the transnational partner primarily engages with adults over 50 years old). Among the participants in Poland, 65% were women and 35% were men, while in Germany, the distribution was 58% women and 42% men. The gender disparity reflected the composition of regular participants in both organizations.

Most of the seniors surveyed had either primary education (Poland: 48%, Germany: 44%) or secondary education (Poland: 32%, Germany: 39%), indicating a low level of formal education, particularly in mathematics. Additionally, in both countries, 15-20% of the participants had disabilities, further increasing their need for support in accessing non-formal education as a tool for social inclusion.

Research Tools

Two main tools were used to assess the mathematical skills of seniors:

- Mathematics Tests – These were designed to evaluate basic competencies such as the ability to calculate percentages, convert units, calculate area and volume, and other fundamental mathematical topics. The tests were based on everyday situations, allowing for a practical assessment of how well participants can apply mathematics in daily life.

- Surveys – These aimed to gather participants' opinions about their educational needs and the barriers they face in the learning process. The surveys asked how seniors perceive mathematics and their experiences with learning and applying it in everyday life. They also included questions about sustainable development and ecological knowledge, providing insight into how these two areas—mathematics and ecology—might be interconnected.

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Additionally, to complement the analysis, interviews were conducted with trainers from the non-formal adult education sector from both partner organizations. These interviews aimed to better understand the challenges trainers face when working with individuals who have low mathematical skills. On the Polish side, 11 educators who regularly work with seniors participated in the study, while on the German side, 9 individuals involved in educational work with adults with low key competencies were interviewed. The educators provided valuable insights into the strategies they use to motivate seniors to learn and the obstacles they encounter in the educational process.

As a result of the detailed analysis of the tests and surveys conducted among seniors in Poland and Germany, we obtained an in-depth diagnosis of the state of their mathematical skills, their perception of mathematics education, as well as the needs and barriers they encounter in this area. The findings were further enriched by interviews with educators, which provided a better understanding of the context of working with individuals in late adulthood.1. Poziom umiejętności matematycznych seniorów

The results of the mathematics tests conducted among 194 seniors in Poland and 117 seniors in Germany confirm that older adults face significant difficulties with basic mathematical skills. In both countries, the greatest challenges are related to calculating percentages, converting units, and understanding more complex mathematical operations connected to managing finances, shopping, or understanding documents.

- Problems with Calculating Percentages

One of the key areas where seniors encounter difficulties is calculating percentages, which has a direct impact on their daily lives, especially in the context of finances. In Poland, as many as 62% of the surveyed seniors were unable to correctly calculate simple percentages, such as a discount on a product or a percentage increase in price. In Germany, this figure was 60%. One of the seniors from Poland stated:

"I feel helpless when I have to calculate how much the price of gas has increased. I have the bills, but those percentages mean nothing to me. Even when something is on sale at the store, I prefer to ask the salesperson because I'm afraid I'll calculate it wrong." – (man, 71 years old, Poland).

The inability to efficiently calculate a percentage from a given number directly impacts daily financial decision-making. As a result, seniors often avoid taking advantage of promotional offers due to fears of "being cheated" and uncertainty.

- Difficulties with Unit Conversion

The second significant area that proved problematic for seniors was unit conversion, such as liters, kilograms, and square meters. In Poland, 55% of seniors had difficulty calculating how many liters of water they use in a day or the area of their apartment. In Germany, a similar percentage (52%) of seniors admitted that unit conversion is challenging for them. This result is particularly important in the context of managing household resources, such as water consumption, electricity usage, or materials used in daily life.

One of the German respondents described their struggles in this way:

„Zawsze miałem problem z przeliczaniem litrów na metry sześcienne. Kiedy próbuję obliczyć, ile wody zużywamy w domu, wszystko się gubi. Nie rozumiem, jak te liczby przekładają się na rachunki, które dostajemy." – (mężczyzna, 65 lat, Niemcy).

The results indicate the need for a more practical approach to learning mathematics, where seniors could develop skills that directly relate to their daily experiences.

- Understanding Mathematics in a Financial Context

In both countries, it was found that seniors also face significant challenges in understanding more complex mathematical operations that are essential for managing finances. This particularly pertains to understanding complex operations such as calculating interest on loans, comprehending changes in interest rates, and analyzing utility bills.

"Interest rates on loans are like black magic to me. When we wanted to take out a loan for home repairs, I didn't know how to calculate any of it. In the end, I had to ask my son to do it for me. I feel like I have no control over my finances." – (woman, 67 years old, Poland).

In Germany, seniors also emphasized that understanding this type of financial operation poses a significant challenge for them. One respondent said:

"The bank sent me a letter about a change in the interest rate on my savings account, but I have no idea what that means for my savings. I'm afraid I'm losing money, but I don't know what to do." – (man, 59 years old, Germany).

The results indicate how essential mathematical education targeted at seniors is, especially in the context of personal financial management. The lack of basic mathematical skills leads to situations where seniors lose control over their finances, further exacerbating their social exclusion.

- Other Mathematical Difficulties in the Surveyed Group

In addition to difficulties with calculating percentages, converting units, and managing finances, the analysis results showed that seniors also face serious problems in understanding proportions and basic statistical concepts. The ability to properly understand proportions is extremely important in daily life—from preparing meals according to recipes to calculating ingredient amounts based on the number of people in the family, as well as in the context of issues like resource conservation or understanding product offers in different units of sale. In Poland, 57% of seniors admitted to having difficulties calculating proportions, while in Germany, this percentage was 52%. One of the respondents described her struggles in this way:

"When I try to prepare a recipe for a larger number of people, I always get confused about how much of each ingredient I need. Proportions are something I've never understood. Even when I try to reduce the amount of ingredients, something always goes wrong." – (woman, 72 years old, Poland).

The problem with proportions often arises from a lack of understanding of the mathematical relationships between numbers and their application in practical situations.

Additionally, seniors struggle to understand basic statistical concepts. Research has shown that as many as 80% of respondents from Poland and 86% of respondents from Germany cannot distinguish between mode and median—most of them were only able to correctly identify what the arithmetic mean is. Statistical concepts, while inherently connected to daily decisions, such as analyzing data related to health, finances, or climate, are difficult for many seniors to grasp.

"I've always thought that all these terms—mean, median, mode—are the same thing. I don’t know what actually distinguishes these concepts or why I should understand them. After all, it doesn’t matter to me in my daily life, right?" – (man, 69 years old, Germany).

The inability to distinguish between basic statistical concepts affects daily decision-making, particularly in the context of analyzing information from media or reports related to, for example, product prices, medical services, or climate change.

Additional difficulties that seniors encounter include understanding and processing data presented in the form of charts and tables. As many as 65% of respondents from Poland and 58% from Germany admitted that they have difficulty interpreting graphs that show changes over time, such as price changes, temperature fluctuations, or resource consumption. Data is increasingly used in daily life—from information about climate change to financial and health offers—making this issue particularly significant.

"In the news on television, they keep showing these graphs about climate change and rising prices, but I don’t understand what it all means. The lines go up or down, but I don't know what that means for me. It just stresses me out because I can't interpret it." – (woman, 70 years old, Poland).

Another significant barrier has proven to be the inability to estimate and make approximations. Over 40% of the surveyed seniors from both countries reported difficulties in estimating outcomes when they need to make quick decisions in the store or at home. They often fear that their estimates will be incorrect, leading to a reluctance to make decisions independently, as described by one of the respondents:

"When I'm in the store, I can't quickly calculate whether it's worth buying a larger package because I can't estimate it. I'm always afraid I'll make a mistake, so in the end, I don't change anything." – (man, 68 years old, Germany).

The results clearly indicate that seniors need support not only in basic mathematical operations but also in more complex cognitive processes, such as data analysis, estimation, and understanding statistics, which are becoming increasingly prevalent in their daily lives.

2. Educational Barriers and Needs of Seniors

The research conducted as part of the project paid special attention to the educational barriers that hinder seniors from learning mathematics and expanding their knowledge of ecology. The results from the surveys and interviews with seniors indicated that most of them have very limited motivation for change and education, often not knowing where they could acquire the necessary knowledge. Additionally, they believe that learning at their age is difficult and impractical. Many expressed the opinion that although they see the need to improve their skills, they "will not go back to school."

- Lack of Motivation to Learn

One of the most frequently cited barriers by seniors was insufficient motivation to pursue learning mathematics. Most respondents admitted that, although they recognized their skills were lacking, they did not feel a strong need to develop them. Many seniors described their lives as "stable," and the need to learn mathematics seemed too distant from their everyday challenges. An example of this can be seen in the statement from one of the study participants:

"I know I have gaps in my math skills, but is it really that important now? After all, I'm retired; no one expects me to do calculations anymore. Besides, those numbers have always scared me." – (woman, 72 years old, Poland).

The lack of motivation often stemmed from the belief that learning mathematics at a later age is too difficult and that making progress would require too much effort. Many individuals recalled their negative experiences with learning mathematics in school, which further influenced their reluctance to return to this subject. As one respondent stated:

"Math has always been my nightmare. I struggled with it in school and barely passed. Now, at my age, I see no point in going back to something that caused me so many problems. And why bother? Just to calculate bills?" – (man, 68 years old, Germany).

The lack of belief in their own abilities also contributed to the low motivation levels among seniors. In the studies, many admitted that they are afraid to take on new educational challenges because they fear failure. Many seniors feel that due to their age, their cognitive abilities have diminished, and learning new things—especially mathematics—seems too complicated.

"My memory isn't what it used to be; I forget what I read, let alone how to calculate anything. I feel like I'm too old to learn. I'm afraid I'll be the worst in the group." – (woman, 73 years old, Poland).

- Lack of Awareness of Available Educational Opportunities

Another significant barrier is the lack of knowledge about available forms of education. Many seniors admitted that they do not know where they could acquire the necessary knowledge in mathematics, finance, or ecology. While some of the respondents expressed a desire to participate in classes, they were unaware of the existence of courses or workshops dedicated to adults of their age.

"I would like to learn how to manage my money better, maybe understand all these bills and offers, but where should I go? I have no idea where to look for such courses."

"If someone invited me, I would try, but I don't know where to start." – (man, 70 years old, Poland).

Many respondents emphasized that adult education—especially for older individuals—is poorly promoted. The lack of information about available educational programs and limited access to modern technologies (computers, internet) leads seniors to feel excluded from the education system. As noted by one of the German respondents:

"I know there are some online courses, but I don't use the internet. Besides, even if I knew, those courses are probably more for younger people, not for me. I certainly won't be going back to school." – (man, 66 years old, Germany).

The belief that adult education is primarily for younger individuals is one of the key reasons seniors do not engage in educational processes. While some of them recognize the need to learn, particularly in the context of everyday mathematical challenges, they believe that learning is "reserved" for younger generations and that they themselves no longer have the opportunity to return to school.

- The Belief That "I Won't Go Back to School"

Many seniors expressed the belief that returning to education—especially formal education—at their age is unrealistic and impractical. Study participants often mentioned that while they see the need to acquire new skills, they do not feel they have the opportunity to return to a traditional education system.

"Mathematics might be useful to me, but I won't be going back to school. It's not that time anymore, not that age. Why do I need it now when I've managed somehow all my life?" – (woman, 68 years old, Poland).

Similar sentiments were expressed by seniors in Germany, who believed that traditional education, including math courses, is not tailored to their needs and life realities:

"Learning is important, I know, but not for me. I'm not going back to school. That's for younger people. I've done my part in life. Now I have other priorities; I just want to peacefully live out the rest of my days." – (man, 72 years old, Germany).

Thus, seniors perceive education as something that primarily occurs in youth and concludes with the completion of formal education. Meanwhile, to encourage older adults to engage in learning, it is essential to offer them new forms of education that meet their needs and lifestyle, while also being easily accessible and flexible.

- Lack of Practicality in Educational Offerings

Seniors often pointed to a lack of practicality in existing educational programs. In many cases, the material available was too theoretical, and seniors did not see a direct connection between the knowledge gained and their daily lives. This discouraged them from pursuing further learning and taking on new educational challenges.

"I once had a math book for adults, but there was so much theory that I got lost. I need something that will help me at home—like calculating bills, understanding store promotions—not diving into complicated stuff." – (woman, 70 years old, Poland).

Similar opinions were expressed among respondents from Germany, who also emphasized the need for practical, everyday knowledge rather than theoretical concepts that have no direct application for them:

"When I wanted to sign up for a course, the program was too academic. I don't need to know how to solve equations or calculate integrals. I need simple skills, like managing money or understanding changes in my electricity bills." – (man, 69 years old, Germany).

Therefore, the educational offerings for seniors must be tailored to their real needs—they must be practical, directly related to their daily lives, and easy to understand and apply.

- Fear of Technology

Many seniors, especially in Poland, also expressed concerns about using new technologies, which served as another barrier to accessing education. In the digital age, many courses and educational materials are available online; however, seniors often do not feel comfortable using computers or smartphones, limiting their ability to participate in such courses.

"My daughter signed me up for an online course, but I didn't even know how to log in. Everything was too difficult, and the small letters on the screen only frustrated me. I gave up right away." – (woman, 71 years old, Poland).

In Germany, seniors also pointed to problems with technology, although to a somewhat lesser extent than in Poland. Educators noted, however, that the lack of digital skills still poses a significant barrier for many older adults who want to develop their skills.

"When I signed up for an online course, I had no idea how it all worked. I tried, but eventually, I asked my son to help me. If it weren't for him, I would have given up." – (man, 68 years old, Germany).

In summary, the surveys clearly indicate that seniors face a range of educational barriers that hinder their ability to engage in learning mathematics and ecology. These barriers include a lack of motivation, disbelief in their own capabilities, a lack of knowledge about available educational options, the belief that learning is for younger people, and technological difficulties. To effectively engage seniors in the educational process, it is essential to address these barriers and propose solutions that are tailored to their specific needs and capabilities.

3. Conclusions from Interviews with Adult Educators

Interviews with educators who work with seniors on behalf of partner organizations in Poland and Germany provided valuable insights into the challenges faced by trainers in working with older adults and the strategies they employ to support seniors in developing their mathematical and ecological skills. The conclusions from these interviews shed light on a deeper understanding of how seniors approach education and how the teaching process can be better tailored to meet their needs.

- Individualized Approach as the Key to Success

One of the most frequently recurring themes in the interviews with educators was the necessity of an individualized approach to each senior. Educators emphasized that the senior group is incredibly diverse in terms of mathematical skill levels, as well as their needs and expectations regarding education. Therefore, as they pointed out, a universal teaching approach did not yield satisfactory results.

"Every senior is different. Some have years of experience working with numbers, while others haven't encountered mathematics in decades. Therefore, they cannot be treated the same. We must adapt the material to their individual needs; otherwise, they quickly lose interest and become discouraged." – (educator, Poland).

Educators emphasized that seniors often require more time to absorb new information, and learning in their case demands patience and significant flexibility from the trainer. Many seniors, due to age and associated cognitive limitations (e.g., decreased concentration and memory), need additional support, necessitating a more individualized approach from educators.

"There is no one path to follow. We must constantly monitor who has what problem and how to help them. Sometimes we need to go back to the basics, and other times we just need to show a different way of thinking. It's a great challenge, but the only way for seniors to truly benefit from it." – (educator, Germany).

- Practical Application of Knowledge – Most Important for Seniors

Educators unanimously acknowledged that pragmatism and the practical application of knowledge are key motivating factors for seniors to engage in learning. Most older adults are not interested in theoretical mathematical education that does not have a direct connection to their daily lives. Instead, seniors want to learn things they can immediately apply in practice, such as calculating bills, converting measurements in the kitchen, managing household budgets, or understanding banking offers.

"Seniors often say they don't want to learn complicated mathematical formulas. They prefer to know how to calculate discounts in the store or how much they will have to pay for utilities. It has to be something that has real value for them, something they can apply right away." – (educator, Poland).

Workshops based on practical examples and exercises related to daily life are the most popular.

Many educators noted that mathematical tasks related to real-life situations, such as budgeting, managing bills, or saving on purchases, receive a positive response from participants.

"When seniors see that what they are learning makes sense and can be applied immediately in their lives, they become more engaged right away. Mathematics becomes less abstract and less intimidating, and more useful." – (educator, Germany).

- Building Confidence – The Key to Overcoming Barriers

Another conclusion from the interviews with trainers was the necessity of building confidence among seniors. Many individuals in late adulthood have negative experiences related to learning mathematics, leading to low self-esteem and fears of failure. Educators emphasized that before effective learning can begin, it is essential to instill in seniors a sense that they are capable of meeting educational challenges. It is also important to adjust the material in a way that avoids educational failure.

"Many seniors come to classes thinking they won't be able to manage. They have a deeply rooted belief that mathematics is too difficult and that it's not for them. Our job is to show them that this is not true. We start with small steps, simple tasks that demonstrate to them that they can understand and solve problems. This builds their confidence." – (educator, Poland).

Educators emphasized that one of the most important aspects of working with seniors is motivating them to take action and gradually building their belief in their own abilities. As seniors acquire new skills, they become more confident, which in turn motivates them to continue learning.

"When seniors see that they can accomplish something, that they are able to calculate bills or understand a bank offer on their own, their attitude changes 180 degrees. They become more open to learning and want to know more." – (educator, Germany).

- The Importance of the Social Aspect of Learni

Educators also highlighted the social aspect of education. For many seniors, participating in workshops and courses is not only an opportunity to acquire new skills but also a chance to connect with others of similar age and experiences. Educators emphasized that creating a friendly atmosphere where seniors feel accepted and supported by the group is crucial for their engagement in the educational process.

"Seniors often say that participating in classes is more than just learning for them. It's a way to spend time with other people and form relationships that are very important to them. That's why we strive to create a friendly atmosphere so that no one feels judged or excluded." – (educator, Poland).

Through joint participation in activities, seniors can share their experiences, support each other, and build social bonds, which in turn makes education more appealing and motivating for them.

"For many seniors, especially those who feel lonely, participating in courses is also an opportunity to meet others. It is often said that social relationships are the driving force for them to continue learning. They feel like they are part of something bigger and that they have support." – (educator, Germany).

- Technological Barriers as a Challenge for Educators

In most interviews with trainers, the topic of technology and its impact on the education of seniors also emerged. In the digital age, more and more educational materials and courses are available online; however, for many seniors, the technological barrier proves to be too high. Educators noted that the lack of skills in using computers and smartphones significantly limits the educational opportunities for older adults, necessitating additional technical support.

"Many seniors simply cannot use a computer. Some are even afraid to try because everything seems too complicated to them. It's a huge challenge, as more and more courses are conducted online, and they are cut off from this opportunity." – (educator, Germany).

Some educators noted that it is necessary to introduce additional technology training sessions to enable seniors to access modern forms of education. Others have attempted to adapt their teaching methods to accommodate these limitations by offering printed materials or organizing in-person classes.

"We have noticed that many seniors feel very discouraged when they see that the course is taking place online. Therefore, we try to organize as many traditional classes as possible to avoid excluding those who struggle with technology." – (educator, Poland).

- The Need for Training for Educators and Access to Methodological Materials

In the interviews, educators also emphasized that to work effectively with seniors, they themselves need appropriate training and support in the form of ready-made materials for conducting workshops. Teaching older adults, who have specific educational needs, requires not only subject matter knowledge but also interpersonal skills and an understanding of the barriers that seniors face.

"Working with seniors requires us to take a completely different approach than working with younger people. We need to be more patient, empathetic, and understand their limitations and fears. That's why we need training to help us manage this role better." – (educator, Germany).

Many educators noted that although they have years of experience teaching adults, working with seniors requires specific knowledge and skills that are not always available in standard teacher training programs.

"I have years of experience working with adults, but seniors are a completely different group. I need additional training that will show me how to motivate them better and how to deal with their concerns. This is new for me, as I have never worked with such a large group of older individuals before." – (educator, Poland).

In summary, the conclusions from the interviews with educators indicate that working with seniors in the areas of mathematical and ecological education requires an individualized approach, practical application of knowledge, and building confidence among participants.

The social aspect of learning is extremely important, and technological barriers present one of the biggest challenges. Additionally, educators themselves need support in the form of training to help them better understand the needs and limitations of seniors in order to effectively achieve educational goals.

4. Recommendations for Further Project Implementation

Based on the results of the conducted tests, surveys, and interviews with seniors and educators, a comprehensive picture emerged of the needs, barriers, and challenges that older adults face in the areas of mathematical and ecological education. The results of the monthly analysis conducted in September 2023 indicate significant issues related to low levels of mathematical skills, gaps in ecological knowledge, as well as numerous psychological, technological, and organizational barriers that hinder seniors from engaging in learning.

- Low levels of mathematical skills negatively impact the daily lives of seniors.

The analysis of mathematical tests revealed that seniors in both countries have significant gaps in basic mathematical skills essential for functioning in modern society. Difficulties in calculating percentages, converting units, managing finances, understanding proportions, and interpreting statistical data have real consequences in their daily lives.

Seniors often struggle to manage their household budgets independently, calculate costs, evaluate store promotions, or analyze utility bills. This reduces their autonomy and increases their dependence on others (most often family members), which can lead to feelings of helplessness and decreased self-esteem in many cases.

"I feel like I'm dependent on others. I can't figure out if a store promotion is worthwhile on my own, and bank statements are like black magic to me." – (woman, 72 years old, Poland).

Gaps in mathematical skills also affect other areas of life, including issues related to environmental protection, managing household resources (e.g., saving water and energy), and the ability to understand information regarding climate change.

- Ecological education among seniors is inadequate, which increases their distance from issues related to sustainable development.

Survey and interview results indicated that seniors are aware that environmental issues are important, but they lack sufficient knowledge and motivation to actively engage in sustainable practices.

The low level of knowledge about ecology and sustainable development primarily stems from the lack of appropriate educational programs aimed at this age group. Most seniors are unfamiliar with basic ecological concepts such as energy conservation, reducing CO_2 emissions, recycling, and waste management. They are unable to assess the impact of their daily decisions on the environment, which leads to limited involvement in pro-environmental activities.

"I know that climate change is important, but I have no idea what I could do to make a difference. I'm not familiar with all those rules that everyone is following now." – (man, 70 years old, Germany).

The lack of access to appropriate educational materials and the ignorance of where and how to obtain information about environmental protection exacerbate the ecological exclusion of seniors. This phenomenon is particularly concerning, as seniors, although no longer active in the workforce, still have a significant impact on resource consumption and waste generation.

- Psychological barriers and low levels of digital skills block access to education.

A lack of motivation to learn and low self-confidence are other key barriers that contribute to educational exclusion among seniors. Negative experiences related to learning mathematics in their youth, a lack of self-esteem, and the belief that "there's no point in learning at this age" significantly diminish their willingness to participate in any educational programs.

"Mathematics has always been my worst subject. Now that I'm retired, what do I need it for? I won't go back to school; I don't have the strength or the desire." – (man, 69 years old, Poland).

Additionally, the technological barrier poses a serious challenge, especially in the age of digitalization, where more and more courses and educational programs are conducted online. Seniors who lack computer or smartphone skills feel excluded from the opportunity to participate in modern forms of education.

"Even if I wanted to learn, all those courses are now online. And I don't know how to use a computer, even if I wanted to sign up." – (woman, 71 years old, Germany).

- The social aspect of education is crucial for seniors.

Educators emphasized that for seniors, education is not just about learning; it is also a form of social activity. Workshops, courses, and classes become opportunities to connect with others of a similar age, which helps build a sense of belonging and reduces feelings of loneliness, a common issue in this age group.

"It’s not just about learning, but also about meeting others. I don’t feel so lonely anymore; I have someone to talk to and share experiences with. This is very important to me." – (woman, 68 years old, Poland).

Therefore, all educational programs aimed at seniors should incorporate social elements, which are an integral motivator for this group. Seniors derive satisfaction not only from the learning itself but also from interacting with other participants in the courses, which enhances their engagement and motivation for further education.

Based on the conducted analysis, detailed recommendations for educational programs for seniors have been compiled below, with particular emphasis on their needs in mathematical and ecological education.

- Practical, Tailored Educational Materials

One of the key conclusions from the research is the need for practical educational materials that directly relate to seniors' daily lives. The workshop scenarios developed within the project are an excellent response to these needs.

The 12 workshop scenarios presented in the next section of the project have been designed to provide educators with tools that are easy to use, understandable for seniors, and based on real-life examples. Each scenario combines mathematical education with ecological issues, making the learning of mathematics more engaging and useful for seniors.

Examples such as calculating household water usage, managing electricity bills, and assessing savings from recycling allow seniors to immediately apply the knowledge they acquire in practice, which enhances their motivation to learn. Rather than focusing on abstract formulas and complicated equations, the scenarios concentrate on situations that seniors encounter in their daily lives, making education more accessible and less discouraging.

"Through these workshops, seniors learn things that they really need in life. It's not dry theory, but something they can apply right after the classes." – (educator, Poland).

- Education Combining Mathematics with Ecology – An Innovative Approach

The integration of mathematical education with ecological issues is an innovative approach that addresses the challenges of the modern world, where environmental protection is becoming a priority. The workshop scenarios demonstrate that mathematics can be effectively used to understand problems related to ecology, such as climate change, natural resource management, and energy conservation.

This way, seniors not only develop their mathematical skills but also increase their ecological awareness, which directly influences their daily decisions regarding consumption, resource conservation, and household management. Workshop participants can learn how to calculate their carbon dioxide emissions from their activities, assess savings from reducing energy consumption, and better understand the impact of their daily choices on the environment.

- Flexibility in Educational Formats – Tailoring to Seniors

For educational programs for seniors to be effective, they must be flexible and tailored to the specific needs of this group. Seniors require materials that align with their learning pace, take into account their cognitive limitations, and are available in various formats—both in-person and online for those who can use technology. Additionally, educational materials should be modular, allowing for customization to the individual needs of participants. Each senior has different experiences and skills, so it is essential for educators to have the flexibility to approach learning based on the participants' levels.

"You can't teach all seniors in the same way. Some need more time to understand certain concepts, while others are more advanced. The materials must be flexible enough for educators to adjust them to different levels." – (educator, Germany).

- Technological Support and Developing Digital Skills

One of the key barriers to accessing education is the lack of digital skills. To enable seniors to fully utilize modern educational programs, it is essential to provide support for learning how to use computers and smartphones. Technology courses should be an integral part of educational programs so that seniors can easily participate in online courses and access available educational materials.

"Seniors who have learned to use computers have much greater access to education. It's worth taking the time to learn basic digital skills because it opens up new opportunities for them." – (educator, Poland).

- Training Programs for Educators

The conclusions from interviews with educators indicate that effective work with seniors requires specialized training for educators. Trainers must not only possess the appropriate subject matter knowledge but also interpersonal skills that will enable them to effectively support seniors in overcoming educational barriers.

Training for educators should cover topics such as: working with older adults, motivating seniors to learn, addressing psychological barriers, and flexibly adapting educational programs to the specific needs of participants.

"Educators need to be well-prepared to work with seniors. It's not the same as working with younger adults. You need to have the right approach, patience, and knowledge of how to support older adults in their education." – (educator, Germany).

The workshop scenarios developed within the project address the educational needs and barriers identified during the analysis. A key value of the partnership is the practical approach to teaching mathematics, which moves away from theoretical, abstract concepts and instead focuses on everyday situations that seniors encounter in their lives. Practical learning, such as calculating bills, conserving resources, or converting proportions in cooking, makes mathematics cease to be a source of stress for seniors and transforms it into a tool for solving real problems.

The integration of mathematical education with ecological topics, which is an innovative element of the project, not only meets the needs of seniors in improving their numerical skills but also enhances their ecological awareness. In the era of climate change and the necessity to promote sustainable development, learning about energy conservation, recycling, and reducing carbon dioxide emissions becomes extremely important.

Seniors who acquire knowledge in ecology will be able to manage their households more consciously and actively contribute to environmental protection, which has both personal and social significance.

The flexibility of the educational formats provided by the project is another key element that addresses the diverse needs of seniors. The classes designed within the scenarios are tailored to different skill levels and can be conducted in either in-person or hybrid formats, allowing for the individualization of the educational process. Adjusting the pace of learning and the ability to adapt materials to participants' levels make seniors feel more confident and willing to engage in activities, as the programs respond to their actual needs rather than imposing rigid rules and limitations.

The project also includes social support, which is extremely important in the education of older adults. Participation in workshops not only allows seniors to acquire new skills but also supports their social integration, countering feelings of loneliness and exclusion. The activities facilitate the exchange of experiences, collaborative problem-solving, and the building of bonds with other participants.

MAIN BODY

12 Scenarios for Ecological-Mathematical Workshops Dedicated to Educators of Adults with Low Mathematical Skills

In this section, we present the intellectual product of the partnership project – 12 scenarios for ecological-mathematical workshops dedicated to educators of adults with low mathematical skills. Each of the developed workshop scenarios is designed to provide participants, regardless of their level of mathematical knowledge, with a comprehensive educational process lasting three clock hours. This duration allows seniors to thoroughly absorb the knowledge and enables them to engage in numerous practical exercises that are crucial for their development.

The structure of the workshops ensures a balance between theory and practice, allowing seniors not only to acquire new information but also to apply it in real life under the guidance of qualified educators. As a result, participants do not remain passive recipients of knowledge – the workshops become an opportunity for active engagement and self-discovery of new mathematical and ecological skills.

Each of the prepared scenarios is a ready-made educational product that can be directly implemented by educators working with adults who have low levels of mathematical skills, particularly seniors. The scenarios include all the necessary elements for conducting comprehensive classes – from well-defined workshop objectives to a detailed plan of the session, along with numerous additional materials that support the teaching process.

Each scenario includes:

- Cataloged Workshop Objectives: These clearly outline the specific skills participants are expected to acquire, such as calculating percentages, converting units of measurement, estimating energy consumption, or managing natural resources. The objectives are clearly defined, allowing trainers to precisely monitor participants' progress (even if the educator is not directly related to the field of mathematics).

- Planned Course of Activities

The workshops have been carefully planned to ensure effective material absorption by seniors. Each scenario consists of an introduction to the topic, a theoretical section discussing key issues, practical exercises that engage participants in active participation, and a summary that helps organize the acquired knowledge and address any questions. The thoughtful structure of the workshops ensures that each stage is logically connected to the previous one, promoting a deeper understanding of the topics discussed. The scenarios include a planned course of the workshops supplemented with additional information for educators.

- Essential Attachments

Each scenario is enriched with a complete set of supplementary materials that are invaluable for both educators and participants. The attachments include, among others, worksheets, independent problem-solving tasks, calculation examples, diagrams, and group activities that engage seniors in active learning. With these materials, educators have a comprehensive toolkit that enables them to conduct the workshops in an engaging and tailored manner.

Flexibility is one of the greatest advantages of the developed scenarios. They can be implemented as part of a comprehensive educational program that includes all 12 workshops. This program serves as an excellent support in developing both mathematical and ecological skills among seniors. However, the workshops can also be conducted selectively, depending on the specific needs of the group. Educators have the option to choose one or several scenarios that best address the participants' needs, thereby tailoring the program to their level of knowledge and individual interests.

An additional element that enriches each scenario is the inclusion of "homework" tasks, which aim not only to reinforce the mathematical knowledge acquired during the workshops but also to facilitate seniors' practical application of this knowledge in their daily lives.

For example, participants may be assigned tasks such as independently calculating their water consumption at home, planning a budget that includes utility bills, or estimating costs related to waste reduction. These assigned tasks allow participants to reflect on the skills they have acquired and actively apply them in real-life situations. For seniors, these exercises provide an excellent opportunity to see how the knowledge gained can impact their daily decisions and attitudes.

Furthermore, some of the exercises included in the scenarios engage participants in independently collecting data from their own lives. Tasks such as monitoring water usage, analyzing electricity bills, or assessing the impact of daily consumption decisions on the environment not only serve as a way to develop mathematical skills but also act as a tool for increasing seniors' ecological awareness. Self-analysis and data collection allow participants to gain a deeper understanding of how their choices affect the natural environment, motivating them to make more conscious decisions.

The workshop scenarios presented in the following sections of this publication have been designed to address the identified needs of seniors and support them in developing essential skills for daily life. They provide educators with an invaluable tool for working with older adults, enabling the integration of mathematical learning with ecological education in a practical and engaging manner.

On the following pages, you will find detailed workshop scenarios that can be implemented as a comprehensive educational program or selectively, depending on the needs and interests of the participant group. We encourage you to utilize the materials, modify them, and adapt the content to meet the individual needs of your learners, and most importantly, to work collaboratively on the development of seniors' skills. Through these workshops, it is possible not only to enhance mathematical competencies but also to build ecological awareness, which is crucial in today's world.

We invite you to make use of the prepared materials and wish you success in conducting the workshops!

Scenario 1: "Is water slipping through your fingers?"

Workshop Objective:

Raise Awareness: Educate participants on the importance of water conservation and the rational management of natural resources.

Develop Mathematical Skills:

- Unit conversion (liters, milliliters, cubic meters)

- Calculating volume and water consumption

- Basic arithmetic skills in a daily context.

Understand Impact**:** Help participants understand how daily choices affect water consumption in their households.

Enhance Practical Skills: Develop practical skills for calculating the costs associated with water usage.

Duration: 3 hours

Required Materials:

- Attachments for the scenario (worksheets, calculation examples, practical tasks),

- Multimedia presentation on water conservation,

- Empty drink containers (bottles 0.5L, 1L, 2L),

- Sample water bills from various households (actual or simulated),

- Timers or mobile phones with stopwatch functionality (to measure shower duration),

- Paper, pens, calculators.

Workshop Plan:

1. Introduction to the topic (20 minutes)

Objective: To raise participants' awareness of the importance of water conservation and basic mathematical skills in the context of ecology.

- Discussion of issues related to water access worldwide – how excessive water use in households affects global resources.
- Brief presentation of statistics: how much water is used per capita daily in Poland and Germany (in liters), compared to countries experiencing water scarcity.
- Presentation of interesting facts about water consumption. These facts aim to make participants aware of how much water is used daily and how easily it can be conserved by making simple changes in their habits. This will make the workshops more interactive and engaging, while also increasing participants' ecological awareness.

Fun Fact: "Did you know that the average person in Poland uses about 35,000 liters of water a year? That's enough to fill 140 large bathtubs!"

Fun Fact: "Turning off the tap while brushing your teeth can save up to 8,000 liters of water annually in a single household. That's enough to flood an entire tennis court with 10 centimeters of water!"

Fun Fact: "Washing dishes under running water can consume up to 100 liters per wash. In contrast, a dishwasher only uses about 10-15 liters for an entire cycle."

Fun Fact: "Shortening showers by 2 minutes can allow an average family to save up to 18,000 liters of water a year – that's equivalent to the weight of a five-ton elephant!"

Fun Fact: "Did you know that the average European consumes about 150 liters of water daily, while people in drought-stricken countries have to survive on less than 20 liters a day?"

Fun Fact: "Producing a single cotton t-shirt requires a whopping 2,700 liters of water – that's the amount an average person drinks over two and a half years!"

Fun Fact: "Every drop of water counts – even a small leak from a faucet dripping one drop per second can waste up to 15 liters of water a day, totaling over 5,000 liters a year!"

Fun Fact: "In just 5 minutes of showering, you use more water than a person living in drought-affected countries does in an entire day."

Fun Fact: "Florida loses over 150 million liters of water daily due to leaks in its water systems. That's enough to supply a small town with water for an entire year!"

Fun Fact: "If each of us shortened our showers by just one minute, we could save enough water to supply hundreds of thousands of people in drought-stricken countries every day."

2. Theory and Practical Exercises (2 hours, including a 10-minute break)

2.1. Presentation and Discussion of Volume Units (20 minutes)

Objective: To present different units of water volume measurement and their practical applications.

Brief Presentation on Unit Conversion: Explain how to convert between liters, milliliters, and cubic meters, and discuss situations in which these units are used.

Example: Show water bottles of varying capacities (0.5L, 1L, 1.5L, 2L) and compare how much water we consume daily.
On average, one person uses about 150 liters of water per day. This estimated consumption includes all daily activities such as washing, cooking, cleaning, flushing toilets, and other household needs. Of course, water usage can vary based on individual habits.

Exercise: Participants convert the volume of water in the bottles from liters to milliliters, and then from milliliters back to liters. (See Attachment No. 1).

2.2. Calculating Water Consumption in the Household (30 minutes)

Objective: Learning how to calculate water consumption based on daily activities.

Discussion of how much water is used during various activities (brushing teeth, showering, washing dishes by hand or in a dishwasher).

Exercise: Participants will calculate, based on their own estimates (or household data), how many liters of water they use for brushing their teeth (2 minutes with the tap running) and how much water is used during a 10-minute shower. (Attachment No. 2)

2.2.3 Practical Group Tasks – Calculating Water Consumption (40 minutes)

Objective:
To raise participants' awareness of how daily choices can impact water consumption reduction and to apply mathematics in practical calculations related to water usage, including unit conversions: liters, cubic decimeters (dm^3), cubic meters (m^3).

Divide participants into groups and assign each group a task to complete (Attachment No. 3):

Group 1:
Calculate how much water a family of four uses when taking 10-minute showers every day for a month.

Group 2:
Calculate how much water the family would save by shortening their shower time by 3 minutes (from 10 minutes to 7 minutes).

Group 3:
Calculate how much water can be saved annually by turning off the tap while brushing teeth (twice a day).

1. Cubic Meter (m^3)

1 cubic meter (m^3) is the volume of a cube with an edge length of 1 meter.
1 m^3 = 1000 liters.
It is a unit commonly used for measuring larger volumes, such as water consumption in households (on water bills).

2. Cubic Decimeter (dm^3)

1 cubic decimeter (dm^3) is the volume of a cube with an edge length of 1 decimeter (10 cm).
1 dm^3 = 1 liter.
The cubic decimeter is equivalent to one liter. It is often used in reference to the volume of beverages, containers, and in cooking.

3. Liter (l)

1 liter (l) is the standard unit of liquid volume.
1 liter = 1000 milliliters (ml).
1 liter = 1 dm^3 (which corresponds to 1 cubic decimeter).
The liter is a commonly used unit in everyday life for measuring the volume of drinks, liquids, fuel, etc.

4. Milliliter (ml)

1 milliliter (ml) is 1/1000 of a liter.
1 ml = 0.001 liters.
1000 ml = 1 liter.
Milliliters are most commonly used for measuring small volumes, e.g., in medicine, cosmetics, beverages, or in culinary recipes

2.4. Cost Simulation – Water Bills (30 minutes)

Objective: Learn how to calculate the costs of water consumption and the savings resulting from more rational water management.

Presentation of Sample Water Bills: Present example water bills (e.g., from different months in a household).

Exercise: Participants are tasked with calculating how much water costs monthly and how costs can be reduced by decreasing water consumption. This includes entering numerical data and calculating monthly savings. (Attachment No. 4).

3. Summary and Practical Tips (30 minutes)

Objective: Strengthen the key points of the workshop and introduce principles of rational water management.

Summary of Key Skills: Review the most important skills – unit conversions, calculating water volumes, and costs.

Brief discussion of practical water-saving tips: e.g., using aerators, turning off the water while washing dishes, installing rainwater harvesting tanks.

Fact: "Did you know that installing an aerator on a faucet can reduce water consumption by up to 30% without compromising user comfort?"

Fact: "Did you know that fixing a leaky faucet can save up to 15 liters of water per day? That's equivalent to 5,000 liters annually!"

Fact: "Reducing daily water consumption by 10% can significantly lower annual household water bills without negatively impacting comfort." (Attachment No. 5).

4. Conclusion and Workshop Evaluation (10 minutes)

Objective: To enable participants to reflect on the knowledge gained and gather their feedback on the workshop.
A short evaluation survey – which information was the most useful, and what they would like to develop further in the future.

Homework (for participants to complete independently):

- Calculate how much water can be saved by shortening shower time by 2 minutes over the course of a week. Assume that 8 liters of water flow through the shower per minute. Calculate how many liters you can save in a week, and then on a monthly and yearly scale.

- Observe your household water meter for a week and record how much water you use each day. Based on this data, calculate your average daily water consumption. Compare your results with the recommended daily water usage per person (150 liters per day). Try to make changes that will help you reduce this consumption.

- Install a simple aerator on your faucet and check how much water you can save over the course of a week by using it during daily activities, such as washing hands or filling a kettle. Record the difference in water consumption before and after using this solution.

- For one week, note how long you brush your teeth each day. Assuming that around 6 liters of water flow through the faucet per minute, calculate how much water you use while brushing your teeth without turning off the faucet. Then, compare the results with the faucet turned off and calculate how much water you can save over the week.

- Measure the amount of water needed to fill the bathtub. Calculate how many liters of water you use for a full bath, then compare that to the amount of water needed for a 5- or 10-minute shower. Calculate how much water you can save by taking a shower instead of a bath. Assume that the shower uses 8 liters of water per minute, while the faucet filling the bathtub flows at about 10 liters per minute.

Attachment No. 1 – Converting Units of Volume

Example 1:

A bottle of mineral water with a capacity of 1.5 liters:
1 liter = 1,000 milliliters,
1.5 liters = 1.5 x 1,000 = 1,500 milliliters.

Example 2:

Converting the capacity of a bottle from milliliters to liters:
2,000 milliliters = 2,000 ÷ 1,000 = 2 liters.

Example 3:

A refillable bottle with a capacity of 750 milliliters. Calculate its capacity in liters:
750 milliliters = 750 ÷ 1,000 = 0.75 liters.

Example 4:

A kitchen jug has a capacity of 2.5 liters. Convert this to milliliters:
2.5 liters = 2.5 x 1,000 = 2,500 milliliters.

Example 5:

On a juice package, you see that its capacity is 3,000 milliliters. How many liters is this?
3,000 milliliters = 3,000 ÷ 1,000 = 3 liters.

Example 6:

An electric kettle has a maximum capacity of 1.7 liters. How many milliliters is this?
1.7 liters = 1.7 x 1,000 = 1,700 milliliters.

Example 7:

Your bathtub holds 120 liters of water. Calculate the capacity in milliliters:
120 liters = 120 x 1,000 = 120,000 milliliters.

Example 8:

An example of smaller capacities: If a medicine bottle has a capacity of 500 milliliters, how many liters is that?
500 milliliters = 500 ÷ 1,000 = 0.5 liters.

Example 9:

You plan to fill a bowl with 4 liters of water. Calculate how many milliliters that will be:
4 liters = 4 x 1,000 = 4,000 milliliters.

Example 10:

A steam cooker uses 1,200 milliliters of water per cycle. Calculate how many liters that is:
1,200 milliliters = 1,200 ÷ 1,000 = 1.2 liters.

Tasks to complete:

- Convert 0.75 liters of water to milliliters.
- Convert 250 milliliters of water to liters.
- Your glass holds 350 milliliters of juice. How many liters is that?
- Convert 1.25 liters of water to milliliters.
- How many liters is 1,800 milliliters of water?
- A bottle of dishwashing liquid has a capacity of 1.5 liters. How many milliliters is that?
- A water bucket has a capacity of 10 liters. How many milliliters is that?
- Your fridge holds a jug with a capacity of 1.2 liters. Calculate the jug's capacity in milliliters.
- While cooking pasta, you use 1.8 liters of water. How many milliliters is that?
- If you cook rice, you need 900 milliliters of water. How many liters is that?

Attachment No. 2 – Calculating Water Usage in the Household

Example 1:

Water usage while brushing teeth (without turning off the water):

We assume that approximately 10 liters of water flow through the faucet per minute.

Brushing teeth takes 2 minutes = 10 liters x 2 minutes = 20 liters of water.

If you brush your teeth twice a day for 2 minutes without turning off the water, you use:

20 liters x 2 brushings per day = 40 liters per day,

40 liters x 30 days = 1,200 liters per month,

1,200 liters x 12 months = 14,400 liters per year.

Example 2:

Water usage during a shower:

We assume that the water flow through the shower is 8 liters per minute.

A 10-minute shower = 10 minutes x 8 liters = 80 liters of water.

If you take a shower every day for 10 minutes, the usage is:

80 liters per day,

80 liters x 30 days = 2,400 liters per month,

2,400 liters x 12 months = 28,800 liters per year.

Now, if you shorten your shower by 2 minutes, the usage will be:

8 minutes x 8 liters = 64 liters per day,

64 liters x 30 days = 1,920 liters per month,

1,920 liters x 12 months = 23,040 liters per year.

How many liters will you save?

Tasks to complete:

- Calculate how many liters of water you use during a 5-minute shower, assuming a flow rate of 8 liters per minute.
- Calculate how many liters of water you use during a 15-minute shower, with a flow rate of 9 liters per minute.
- Calculate how much water you save if you turn off the water while brushing your teeth (assuming 2 brushings per day, each lasting 2 minutes, with a flow rate of 10 liters per minute).
- Calculate how much water you will save in a month if you reduce a 10-minute shower (with a flow rate of 9 liters per minute) to a 7-minute shower.
- Calculate how much water you will use in a month if you hand wash dishes every day for 10 minutes, with a faucet flow rate of 12 liters per minute. Then compare this with the monthly water consumption of a dishwasher, which uses 15 liters per cycle and is run every other day.

Answers:

40 liters of water, 135 liters of water, 40 liters saved per day, 810 liters saved per month, 3,375 liters saved monthly by using a dishwasher

Attachment No. 3 – Calculating Water Usage

Group 1:

Calculation of how much water a 4-person family uses, each taking 10-minute showers every day for a month. We assume that 8 liters of water flow through the shower per minute.

Water usage during a 10-minute shower:
……………………………………….. liters of water per person.

For a 4-person family:
………………………………………..

Calculation of the monthly water usage for the family (assuming the month has 30 days):
………………………………………….. liters per month.

Converting liters to cubic meters (1 m³ = 1,000 liters):
………………………………………….. m³

Result: A 4-person family uses … m³ of water per month just for showers.

Group 2:

Calculation of how much water the family would save by shortening shower time by 3 minutes (from 10 minutes to 7 minutes).
We assume that the water flow is 8 liters per minute.

Water usage during a 7-minute shower:
……………………………………….. liters of water per person.

For a 4-person family:
………………………………………..

Calculation of monthly water usage:
Calculation of monthly water usage for the family (assuming the month has 30 days):
……………………………………….. liters per month.

Converting liters to cubic meters (1 m³ = 1,000 liters):
………………………………………….. m³

Result: Shortening the shower to 7 minutes will save:
…………………… (Collaborate with Group 1!)

Group 3:

Calculation of how much water can be saved annually by turning off the water while brushing your teeth (twice a day).

We assume that 10 liters of water flow through the faucet per minute.

Brushing teeth takes 2 minutes. If the water is not turned off, the usage is:

……………………………… liters per brushing.

Two brushings per day:

……………………………… liters.

Calculation of annual usage (assuming the year has 365 days):

……………………………… 14,600 liters annually.

Converting liters to cubic meters (1 m³ = 1,000 liters):

……………………………… 14.6 m³.

If you turn off the water while brushing your teeth, you use a minimal amount of water (e.g., 1 liter per brushing to rinse the toothbrush).

1 liter x 2 times a day = 2 liters per day,

2 liters x 365 days = 730 liters per year = 0.73 m³.

Result: Turning off the water while brushing your teeth can save:

……………………………… liters of water annually.

Attachment No. 4 – Cost Simulation – Water Bills

Average water price per cubic meter, or 1 m^3, in Poland is about 9-10 PLN. Converted to liters, a single liter of water costs around 0.009 PLN, which is less than a penny. However, this price may vary significantly depending on the region and whether sewage treatment costs are included. In comparison, the average price of water in Germany is around 1.8 euros per cubic meter, including taxes.

Task 1: Calculating water usage by a washing machine

Your washing machine uses 60 liters of water per cycle. Let's assume you do laundry 20 times a month. The price of 1 m^3 of water is 9 PLN.

Step 1: Calculate the total water usage in liters by the washing machine over the course of a month.

.... liters.

Step 2: Convert liters to cubic meters (1 m^3 = 1,000 liters).

.... m^3.

Step 3: Calculate the monthly cost of water usage by the washing machine.

.... PLN.

Task 2: Calculating water usage during baths

Assume you take a bath 4 times a week, and each bath uses 150 liters of water. Calculate the monthly water usage and cost if the price of 1 m^3 is 10.50 PLN.

Step 1: Calculate weekly water usage.

.... liters per week.

Step 2: Calculate monthly water usage (assume the month has 4 weeks).

.... liters per month.

Step 3: Convert liters to cubic meters.

.... m^3.

Step 4: Calculate the monthly cost of water usage.

.... PLN.

Task 3: Water savings by reducing shower time

Assume your shower usually lasts 10 minutes, and the water flow is 9 liters per minute. Now, you decide to reduce the shower time to 6 minutes. Calculate how much water you will save in a month and how the monthly bill will change if you take a shower every day. The price of 1 m^3 of water is 11 PLN.

Step 1: Calculate water usage per shower before the change.
.... liters per shower.

Step 2: Calculate monthly water usage before the change.
.... liters.

Step 3: Convert liters to cubic meters.
.... m^3.

Step 4: Calculate the monthly cost of water before the change.
.... PLN.

Step 5: Calculate water usage per shower after reducing the time to 6 minutes.
.... liters per shower.

Step 6: Calculate monthly water usage after reducing the shower time.
.... liters per month.

Step 7: Convert liters to cubic meters.
.... m^3.

Step 8: Calculate the monthly cost after the change.
.... PLN.

Step 9: Calculate the monthly savings.
.... PLN per month.

Task 4: Water usage in the kitchen

Assume that every day you boil water for tea, using 1 liter of water. For hand-washing dishes, you use 20 liters of water daily. Calculate the monthly water usage and cost if the price of 1 m³ is 8.50 PLN.

Step 1: Calculate monthly water usage for tea.
………………………………… liters per month.

Step 2: Calculate monthly water usage for dishwashing.
………………………………… liters per month.

Step 3: Calculate total monthly water usage.
………………………………… liters per month.

Step 4: Convert liters to cubic meters.
………………………………… m³.

Step 5: Calculate the monthly cost of water usage.
………………………………… PLN.

Task 5: Calculating water usage in the garden

Assume you water your garden 3 times a week, using 50 liters of water per watering. Calculate how much water you use monthly and the water bill if the price of 1 m³ is 7.50 PLN.

Step 1: Calculate weekly water usage.
………………………………… liters per week.

Step 2: Calculate monthly water usage (assuming 4 weeks in a month).
………………………………… liters per month.

Step 3: Convert liters to cubic meters.
………………………………… m³.

Step 4: Calculate the monthly cost of water usage.
………………………………… PLN per month.

Attachment No. 5 – Practical Tips for Saving Water

- Timed Showers
  You can set an alarm on your phone (e.g., 5 minutes) to remind you to limit the time spent in the shower. This is a great way to control water usage and save daily.

- Using Ice Cubes to Water Small Plants
  Instead of pouring water to water small potted plants, you can place a few ice cubes on the soil's surface. The gradually melting ice will slowly hydrate the plants, which is especially useful for plants that don't need large amounts of water.

- Use Cooking Water from Vegetables as a Natural Fertilizer
  The water in which you cooked vegetables is rich in nutrients such as potassium and phosphorus. After cooling, you can use this water to irrigate garden or house plants, providing them with a natural fertilizer.

- Using Reusable Water Bottles with Filters

Instead of buying bottled water, use reusable bottles with built-in filters. This not only saves money on bottled water but also reduces the resources wasted on plastic production.

- Create „Eco-Glasses"

Instead of washing several glasses throughout the day, assign yourself one "eco-glass" for the entire day. Use it for all your beverages, reducing the number of dishes to wash and the amount of water used.

- Share 5 of Your Own Creative Water-Saving Ideas

Encourage participants to come up with their own innovative ways to save water in their daily routines!

Scenario No. 2:
"Can you pay lower bills?"

Workshop Objective:

Understanding the concept of percentages and percentage points, and their application in everyday situations such as bills, savings, and survey results.

Strengthening the ability to calculate percentages of a given value and improving arithmetic skills, which will assist seniors in managing their finances.

Increasing awareness of the difference between percentages and percentage points.

Promoting ecological awareness through "small changes" in daily habits.

Duration: 3 hours

Required Materials:

- Sample utility bills (electricity, water, and gas) or bills brought by participants.
- Calculators (one per person).
- Sets of worksheets with calculation examples (attachments).
- A whiteboard or flipchart for visualizations.
- Pens and notebooks for participants.
- Examples of discount coupons and store promotions.
- Cards with survey results, interest rates, and discounts.

Workshop Plan:

Introduction to the Topic (Example with a Survey and a Brief Discussion on the Role of Percentages in Daily Life) – 20 minutes

Welcome participants and present the objectives of the workshop.

Start by asking a question that introduces the concept of the difference between percentages and percentage points:
Opening Question for Discussion:
"If one political party has 10% support, and another has 12%, can we say that the second party has 2% more support?”

Most participants will intuitively say "yes," but this is a misconception.

Explanation: In reality, the difference in support is 2 percentage points, not 2%. If we were talking about percentages, the difference would be 20% – because the difference between 10% and 12% in relation to 10% is indeed 20% more (12% is 120% of 10%).

Example:
If one product costs 100 PLN, and another costs 120 PLN, we can say that the second product is 20% more expensive. The same applies to political support in a survey—the difference is 20% of one party's support in relation to the other.

After presenting the first example, conduct a 10-minute discussion on the role of percentages in daily life—discounts, taxes, savings, loans, and bills.

Start with a brief introduction:
Introduction:
"Percentages play a crucial role in many aspects of our daily lives, from shopping to managing personal finances. Understanding how percentages work helps us make better financial decisions, save money, and control spending."

Discussion Question:
"In what situations have you encountered the concept of percentages? (in stores, in the bank, in advertisements, in the news, taxes, etc.)"

Provide a few specific examples, and remember to write the calculations on the board or flipchart to help participants visualize the math behind them.

1. Discounts in Stores

Percentages are most commonly encountered during shopping, in the form of discounts and promotions. When we see a “20% discount,” it means we can pay 20% less than the original price of the product. Understanding how this works allows us to calculate exactly how much we can save.

Example:

If a product costs 200 PLN and is offered with a 20% discount, it means we will pay 40 PLN less (20% of 200 PLN = 40 PLN). The final price will therefore be 160 PLN.

Interesting Fact:

Stores often use so-called "progressive discounts," for example, 20% off the first product, 30% off the second, and 40% off the third. Calculating such discounts requires understanding how different percentages affect the total cost of purchases.

2. Taxes

In the tax system, percentages also play a significant role. Each of us pays taxes on income, property, or goods and services (VAT). The amount of these taxes is expressed as a percentage of the base value (also known as the net value).

VAT (Value Added Tax):

It is one of the most common taxes. In Poland, it is 23%. This means that when you buy a product in a store for 100 PLN, you are actually paying 81.30 PLN for the product itself (net value), and 18.70 PLN is the VAT. The total amount of 100 PLN is the gross price of the product.

Example:

If the gross price (including VAT) is 123 PLN, and the VAT rate is 23%, we can calculate that the net price is 100 PLN (123 PLN ÷ 1.23 = 100 PLN).

Calculating taxes is an important issue not only for business owners but also for all informed consumers.

3. Savings and Deposits

Percentages also play a key role in managing savings. When you deposit money in a savings account or a term deposit, the bank calculates interest, which is expressed as a percentage of the amount deposited. The higher the interest rate, the more you earn on your savings.

Example:

If you deposit 1,000 PLN in a savings account with an annual interest rate of 3%, after one year you will earn 30 PLN in interest (3% of 1,000 PLN = 30 PLN).

In the case of deposits, it's important to pay attention to the interest capitalization periods, such as quarterly, semi-annual, or annual. In the example above, we assumed one annual capitalization. Generally, the more frequently the bank capitalizes interest (adds earnings to the deposit), the better it is for the saver. Interestingly, the same annual interest rate can yield different earnings depending on the capitalization period—we will revisit this in a later part of the workshop.

4. Loans and Borrowing

When taking out a loan or credit, we pay interest, which is expressed as a percentage. The interest rate indicates how much we will pay in addition to the borrowed amount. Understanding how interest rates work helps assess which loan is more affordable and how much the total cost of borrowing will be.

Example:

If you take out a loan of 10,000 PLN for 5 years with an interest rate of 6%, it means that the annual interest will be 600 PLN (6% of 10,000 PLN), which over 5 years will total 3,000 PLN in interest.

It’s important to note "what the interest is calculated on"—whether it’s based on the total loan amount (as in the example above) or on the remaining balance yet to be repaid. The latter option is more favorable for the borrower.

Percentage Points:

In the case of loans or credit, the term percentage points is often used. For example, if the interest rate on a loan increases from 5% to 7%, the difference is 2 percentage points, which directly affects the increase in loan payments.

5. Utility Bills (Electricity, Water, Gas)
Many of us encounter percentages in the context of utility bills. Percentage figures can refer to price increases for electricity, water, or gas, but also to the savings we can achieve, for example, by reducing energy consumption by a certain percentage.

Example of Savings:
If your electricity bill is 300 PLN per month, and by using energy-saving bulbs you reduce energy consumption by 10%, the bill will decrease by 30 PLN, to 270 PLN.
Over the course of a year, this change will bring savings of 360 PLN.

Price Increases:
If the price of electricity increases by 5%, and your monthly bill is 300 PLN, you will have to pay an additional 15 PLN per month. Over the course of a year, this amounts to 180 PLN more.

Summary – Why is it Important to Understand Percentages?

Understanding how percentages work is essential for making informed financial decisions. It helps with day-to-day household budgeting, optimizing expenses, and assessing the profitability of loans, savings accounts, or investments. By knowing how to calculate percentages, we can better plan our finances, minimize costs, and increase savings.

Understanding the difference between percentages and percentage points is particularly important, as misinterpreting these concepts can lead to poor financial decisions, such as choosing an unfavorable loan offer or incorrectly evaluating utility bills and taxes.

And with these skills and knowledge, you will conclude today's workshop!

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Theoretical Introduction (20 minutes)

Percentages are a concept we encounter daily in various situations, both financial and ecological. Percentages help us better understand relationships between values and facilitate comparisons in many areas of life—from shopping to managing the use of natural resources. Understanding how percentages work is crucial for making informed and rational financial and environmental decisions.

1. Definition of a Percentage:
A percentage is a unit of measurement that expresses how much of a whole a particular value represents. It is a special way of writing fractions—1% is one hundredth of the whole. Therefore, a percentage simplifies the relationship between numbers and value, allowing for easy comparisons.

Example:
If you have 100 PLN and someone offers you a 10% discount, it means the price of the product is reduced by 10 PLN, because 10% of 100 PLN is 10 PLN.

The Reality of Percentages:

A percentage never exists in isolation—it always refers to a specific value from which it is calculated. We cannot speak of "percentages" without referring to an initial value, because a percentage is always a part of a whole.

Important Rule:
A percentage is always a percentage of something. For example, 10% of 200 PLN is 20 PLN, and 10% of 1,000 PLN is 100 PLN. Without specifying the initial value, the concept of percentage makes no sense, so we always need to provide the context to which the percentage refers.

Example – How to Calculate a Percentage of a Given Number:
Let's say you want to calculate 20% of 250 PLN. Here's how to do it step by step:

Step 1: Convert the percentage into a decimal.
A percentage is a fraction of a whole, specifically one hundredth. To calculate a percentage, you need to convert it into a decimal.
20% is equivalent to 20/100, which is 0.20.

Step 2: Multiply the Number by the Percentage (in Decimal Form)
Now, you need to multiply the amount by the decimal number you obtained in Step 1.
250 PLN x 0.20 = 50 PLN.

Step 3: Result
20% of 250 PLN is 50 PLN.

Formula Summary:
To calculate a percentage of a given number, you can use this simple formula:
Percentage of a number = Value of the number × (Percentage ÷ 100)

Another Example:
If you want to calculate 15% of 400 PLN, follow the same steps:
15% = 0.15
400 PLN x 0.15 = 60 PLN
15% of 400 PLN is 60 PLN.

This method of calculating percentages is very practical in everyday life—for example, while shopping.

Difference Between Percentage and Percentage Point:

In discussions about finances or surveys, the term percentage point often comes up. It is a specific measure of change in percentage values.

Percentage: This refers to calculating a fraction of an initial value. For example, a 20% discount on a product worth 150 PLN is 30 PLN (20% of 150 PLN = 30 PLN).

Percentage Point: This refers to the difference between percentage values. When we talk about percentage points, we are referring to a change in the percentage value itself, not the initial value. For example, if the interest rate on a loan increases from 10% to 12%, the increase is 2 percentage points, not 2%. This is important because these concepts are often confused.

Practical Example:
Let’s assume the interest rate on your savings account is 5%, but the bank raises it by 2 percentage points. This means the new interest rate is 7%. This does not mean a 2% increase, but rather an increase of 2 percentage points. This difference can have a significant impact on the total profit from savings or the cost of a loan.

Introduction to the Practical Part of the Workshop

Percentages and percentage points are omnipresent in our lives—we encounter them everywhere, from daily shopping to financial decisions, and even in ecological efforts. Understanding these concepts not only simplifies managing our finances but also supports the adoption of eco-friendly habits that can benefit both our household budget and the environment.

During today's workshop, we will practice how to apply percentages in various real-life situations. In addition to calculating a percentage of a given number, we will also learn how to calculate what percentage one value is of another. These are valuable skills that will help us with everyday tasks such as:

- Comparing discount offers,
- Calculating savings on electricity or water bills,
- Better managing the household budget,
- And understanding how our decisions impact natural resource consumption and environmental protection.

Through these exercises, you will become more adept at making informed financial and ecological decisions in your daily life.

Understanding percentages and their application allows not only for making informed financial decisions but also for implementing ecological practices that can bring long-term benefits. Today, we will focus on practical exercises that will show us how percentages can help optimize our expenses and actions.

2.2. Individual Exercises – Calculating Percentages (20 minutes)

Each participant will receive a set of tasks (Attachment No. 1) that will help apply percentage calculations to everyday situations.

Before starting the independent work, provide a brief introduction by writing a few examples on the flipchart:

10% of 200 PLN = 20 PLN (electricity bill),

15% of 450 PLN = 67.50 PLN (savings on promotions),

20% of 1,000 PLN = 200 PLN (shopping discounts).

Example (Store Discount):
"If a store offers a 15% discount on an item worth 500 PLN, how much will you save, and how much will you pay?"

Calculate how much you will save on your electricity bill if you replace regular light bulbs with energy-saving ones that reduce energy consumption by 20%. Assume your monthly electricity bill before changing the bulbs is 300 PLN.

Example: If your bill is 300 PLN, you will save 20% of that amount, which is 60 PLN per month. Over a year, this gives you a saving of 720 PLN.

Interest Rate Example: If the interest rate on your deposit increases by 3 percentage points (from 2% to 5%), calculate how much additional interest you will earn on 10,000 PLN.

Solution: The profit will increase from 200 PLN annually (2%) to 500 PLN annually (5%), which gives an additional 300 PLN in interest.

Distribute the worksheets to participants—they have 15 minutes to complete the tasks. They can work in pairs or individually.

2.3. Group Exercises – Calculating Savings in the Household Budget (30 minutes)

In this part of the workshop, participants will work in groups to calculate how reducing energy and water consumption can impact their bills and help protect the environment. Each group will receive a set of tasks to optimize their household budget.

Group Tasks:

Group 1: Electricity Savings
Participants calculate how much can be saved on the electricity bill if traditional light bulbs are replaced with energy-efficient LED bulbs, which reduce electricity consumption by 15%.

Group 2: Store Discounts
Participants calculate savings on purchases using a 20% discount promotion on various products. They must compare how much they will pay for products with different prices and calculate the total savings value.

Group 3: Water Savings
Participants calculate how much water can be saved by installing a faucet aerator, which reduces water usage by 30%. They also calculate the savings on water bills over a 6-month period.

Attachment No. 2 – Calculation Scenarios for Groups (Optimizing Household Budget and Utility Bills).

2.4. Calculating Bills – Practical Exercises (30 minutes)

In this part of the workshop, participants will work with real electricity, water, and gas bills. Each group will calculate savings from reduced consumption and explore potential savings from switching energy providers.

Task 1: Water Savings
Calculate how reducing water consumption by 20% will impact your annual water bill. Consider both financial and ecological savings resulting from reduced drinking water usage.

Task 2: Changing Electricity Provider
Calculate how much you will save on your electricity bill if you switch to a provider that is 5% cheaper. Consider whether it's worth investing in solar panels to reduce long-term costs.

Attachment No. 3 – Sample Bills for Analysis and Calculations

2.5. Calculating Personal Savings – Using Household Data (20 minutes)

Each participant brings their own utility bills (electricity, water, gas) and uses them to perform individual calculations that will help them achieve real savings. This will enable participants to understand how percentages affect their household budget and how eco-friendly actions can help reduce costs.

Electricity: Calculate how switching from regular bulbs to energy-saving ones will affect your bills. What will the savings be after a year?
Example: Replacing all bulbs in your home reduces electricity consumption by 15%, which, for a monthly bill of 250 PLN, means a saving of 37.50 PLN per month, or 450 PLN per year.

Water: Calculate how much water can be saved by installing aerators on your faucets. How many liters of water and how much money will you save in a year?
Example: With a monthly water consumption of 8 m^3, installing aerators reduces this consumption by 2.4 m^3, which, at a price of 10 PLN per m^3, results in a saving of 24 PLN per month, or 288 PLN per year.

Gas: How can changing your cooking style (e.g., cooking on lower heat or using lids) affect savings? What are the ecological and financial effects?
Example: Saving 10% on gas usage can result in 150 PLN saved annually.

Attachment No. 4 – Calculation Scheme for Your Own Bills

2.6. Calculating What Percentage One Number is of Another (20 minutes)

In this section, participants will learn how to calculate what percentage one value is of another. This is particularly useful for analyzing how much of the household budget is consumed by specific expenses.

Example Task:

Calculate what percentage the water bill (300 PLN) is of the total monthly household budget of 3,000 PLN.

Solution:

300/3000 × 100 =10%

Calculate what percentage a 100 PLN savings on the gas bill represents out of total annual utility expenses of 5,000 PLN:
Solution:

100/5000 × 100 = 2%

The savings represent 2% of the annual utility expenses.

Attachment No. 5 – Tasks Related to Calculating What Percentage One Value is of Another

Note on Calculating Percentages: Principle of Uniform Units

To correctly calculate what percentage one number is of another, both numbers must be expressed in the same units. This means if we are comparing amounts, they must be in the same currency, such as PLN or groszy. If we are calculating percentages for volume, all values must be expressed in liters, milliliters, or cubic meters. Without uniform units, percentage calculations will not make sense.

Example – Principle of Uniform Units:

Let's say you want to calculate what percentage 300 groszy represent compared to 60 PLN. In this case, we have two different units—groszy and PLN.

Problem: Without converting the units, the calculation will not be correct because we cannot directly compare values in groszy and PLN.

Solution: Convert both values to the same unit, for example, PLN.
300 groszy is equal to 3 PLN (since 1 PLN = 100 groszy).

Now, calculate what percentage 3 PLN is of 60 PLN:

3/60 × 100 = 5%

Answer: 3 PLN represents 5% of 60 PLN.

What happens if we don't use uniform units?

If you try to calculate what percentage 300 groszy is of 60 PLN without converting the units, the result will be incorrect, because the values in groszy and PLN are not directly comparable.

300/60 x 100% = 500%, which is an incorrect result of 500%, instead of the correct 5%.
Therefore, always remember to ensure that the numbers being compared are in the same units of measurement before starting percentage calculations—this is key to obtaining accurate results.

3. Conclusion and Workshop Evaluation (10 minutes)

Objective: To enable participants to reflect on the knowledge gained and gather their feedback on the session.

Short Evaluation Survey: Which information was the most useful, and what would they like to develop further in the future?

Homework (for independent completion by participants):

Homework 1: Energy Savings in the Kitchen
Measure how much energy you use to cook dinner for a week (in kilowatt-hours). Then, make simple eco-friendly changes, such as cooking with a lid on, using a pressure cooker, or cooking at a lower power level for the next week

.Task: Calculate by what percentage your energy consumption decreased after implementing these changes.

Homework 2: Switching to Energy-Efficient Appliances

Calculate what percentage of your annual electricity consumption is used by old appliances (e.g., refrigerator, washing machine). Consider how much energy you could save if you replaced them with more energy-efficient ones.

Task: Look up the specifications of new energy-efficient appliances online and calculate how much energy you could save annually (in percentage terms) if you decide to upgrade.

Homework 3: Discounts on Eco-Friendly Products

Choose 3 eco-friendly products that you buy regularly (e.g., organic vegetables, fair trade items). Check the prices of these products in the store and compare them with the prices of standard products.
Task: Calculate how much more (in percentage terms) you pay for eco-friendly products compared to standard ones. Then calculate how much you would save if eco-friendly products were 10% cheaper.

Homework 4: Reducing Water Usage
For a week, record your water usage during daily activities such as washing dishes, showering, and watering plants. Then, try to reduce your water usage by, for example, taking shorter showers, turning off the tap while brushing your teeth, or using the dishwasher.

Task: Calculate by what percentage you managed to reduce your water usage during the week, and convert that into the number of liters saved.

Attachment No. 1 – Practical Application of Basic Percentage Calculations

Below is a set of 10 simple, practical examples that will help you calculate percentages of a given number. The tasks are based on everyday situations related to finances, shopping, bills, and ecological savings. Good luck!

1. Discount in a Grocery Store
The product costs 250 PLN. The store offers a 10% discount. Calculate how much you will save and what the final price will be after the discount.

Step 1: Calculate the discount amount (find 10% of 250 PLN):

....

Step 2: Calculate the price after the discount (subtract the discount value calculated above from 250 PLN):

....

2. Electricity Bill

Your monthly electricity consumption is 200 PLN. If you reduce electricity usage by 15%, what will your new bill be? Calculate the amount saved.

....

....

3. Water Bill

Your monthly water bill is 150 PLN. Installing aerators will reduce water consumption by 20%. Calculate the new bill after installing aerators and how much you will save monthly.

....

....

4. Clothing Discount

The cost of shopping at a clothing store is 400 PLN. The store offers a 25% discount. Calculate how much you will save and how much you will pay after the discount.

……………………………………………

……………………………………………

5. Gas Bill

The annual gas bill is 1200 PLN. Due to switching providers, the bill decreases by 10%. Calculate the new annual amount to be paid and the savings.

……………………………………………

……………………………………………

6. Household Appliance Purchase

The purchase of a washing machine costs 1800 PLN. The store offers a 15% discount. Calculate how much you will save and how much you will pay for the washing machine after the discount.

……………………………………………

……………………………………………

7. Deposit Interest

You have 10,000 PLN in a savings account that earns 3% interest annually. Calculate how much interest you will earn after one year.

……………………………………………

……………………………………………

8. Eco-Friendly Lighting

Your monthly electricity bill is 250 PLN. Changing all light bulbs to energy-efficient ones will reduce electricity consumption by 20%. Calculate the new monthly bill and the savings over the course of a year.

……………………………………………

……………………………………………

9. Language Course Discount

The cost of a language course is 800 PLN. The school offers a 30% discount. Calculate how much you will pay for the course after the discount.

……………………………………………

……………………………………………

10. Water Savings

Your annual water consumption is 120 m³. Installing water-saving devices reduces water usage by 15%. Calculate the new annual water consumption and the amount saved, assuming a price of 10 PLN per 1 m³ of water.

…………………………………………….

…………………………………………….

Answers:

1. Discount in a Grocery Store

Calculation: 10% of 250 PLN = 25 PLN.

Price after discount: 250 PLN - 25 PLN = 225 PLN.

2. Electricity Bill

Calculation: 15% of 200 PLN = 30 PLN.

New bill: 200 PLN - 30 PLN = 170 PLN.

3. Water Bill

Calculation: 20% of 150 PLN = 30 PLN.

New bill: 150 PLN - 30 PLN = 120 PLN.

4. Clothing Discount

Calculation: 25% of 400 PLN = 100 PLN.

Price after discount: 400 PLN - 100 PLN = 300 PLN.

5. Gas Bill

Calculation: 10% of 1200 PLN = 120 PLN.

New bill: 1200 PLN - 120 PLN = 1080 PLN.

6. Household Appliance Purchase

Calculation: 15% of 1800 PLN = 270 PLN.

Price after discount: 1800 PLN - 270 PLN = 1530 PLN.

7. Deposit Interest

Calculation: 3% of 10,000 PLN = 300 PLN.

Annual profit: 300 PLN.

8. Eco-Friendly Lighting

Monthly Calculation: 20% of 250 PLN = 50 PLN.

New monthly bill: 250 PLN - 50 PLN = 200 PLN.

Annual savings: 50 PLN x 12 months = 600 PLN.

9. Language Course Discount

Calculation: 30% of 800 PLN = 240 PLN.

Price after discount: 800 PLN - 240 PLN = 560 PLN.

10. Water Savings

Calculation: 15% of 120 m³ = 18 m³.

New water consumption: 120 m³ - 18 m³ = 102 m³.

Annual savings: 18 m³ x 10 PLN = 180 PLN.

Attachment No. 2 – Calculation Scenarios for Groups: Optimization of Household Budget and Utility Bills

The following tasks are a bit more advanced and are intended to optimize utility usage and calculate savings. The tasks relate to everyday situations such as saving energy, water, and discounts in stores.

Group 1: Electricity Savings
Scenario: Participants calculate how much can be saved on the electricity bill if they replace all traditional light bulbs in their home with energy-efficient LED bulbs.

Assumptions:

- The monthly electricity bill is 500 PLN.
- Replacing the bulbs will reduce energy consumption by 15%.
- Additionally, energy consumed during peak hours (60% of the bill) costs 10% more than during off-peak hours.

Task:

- Calculate how much you will save on the bill after replacing the bulbs, considering a 15% reduction in consumption.
- Calculate how reducing energy consumption during peak hours will affect the total bill. What is the monthly savings, and what is the annual savings?

Hints:

- Calculate 15% of 500 PLN.
- The bill during peak hours accounts for 60% of the total bill. Calculate how much you will save by reducing consumption by 15% in this portion of the bill.

Group 2: Store Discounts

Scenario: Participants calculate savings on purchases using a 20% discount promotion on selected products in the store. The store has products with different prices:

- Product A: 400 PLN
- Product B: 250 PLN
- Product C: 150 PLN

Task:

- Calculate the total bill if you buy one of each of these products with a 20% discount.
- Calculate the total savings value when purchasing all three products with a 20% discount.
- Determine which is more cost-effective: buying the products with a 20% discount (all 3 products at the same discount rate) or buying the products with the following discount rule: "The cheapest product is 30% off, the next product is 20% off, and the most expensive product is 10% off!".

Hints:

- Calculate 20% of the price of each product. Determine the cost of each product after the discount, then sum the resulting values.
- Add the individual savings to obtain the total savings value.
- Calculate 30% of Product A's price, 20% of Product B's price, and 10% of Product C's price. Compare this with the total savings value you obtained in the previous task.

Group 2: Store Discounts

Scenario: Participants calculate savings on purchases using a 20% discount promotion on selected products in the store. The store has products with different prices:

- Product A: 400 PLN
- Product B: 250 PLN
- Product C: 150 PLN

Task:

- Calculate the total bill if you buy one of each of these products with a 20% discount.
- Calculate the total savings value when purchasing all three products with a 20% discount.
- Determine which is more cost-effective: buying the products with a 20% discount (all 3 products at the same discount rate) or buying the products with the following discount rule: "The cheapest product is 30% off, the next product is 20% off, and the most expensive product is 10% off!".

Hints:

- Calculate 20% of the price of each product. Determine the cost of each product after the discount, then sum the resulting values.
- Add the individual savings to obtain the total savings value.
- Calculate 30% of Product A's price, 20% of Product B's price, and 10% of Product C's price. Compare this with the total savings value you obtained in the previous task.

Group 3: Water Savings

Scenario: Participants calculate how much water can be saved by installing aerators on faucets, which reduces water consumption by 30%.

Assumptions:

- Monthly water usage is 12 m^3 for a family of three.
- Data indicates that average water consumption per person in Poland ranges from 92 to 150 liters per day, which translates to 3 to 4.5 cubic meters per month per person.
- The cost per cubic meter of water is 10 PLN.
- Calculations are for a period of 6 months.

Task:

- Calculate how much water the family will save per month after installing the aerators, assuming a 30% reduction in usage.
- Calculate the amount of monthly savings in PLN.
- Calculate the savings over 6 months.

Hints:

- Calculate 30% of 12 m^3 to determine the monthly water savings.
- Calculate the monthly savings on the bill by multiplying the amount of water saved by the price per cubic meter of water.
- Multiply the result by 6 to obtain the savings over 6 months.

Answers:

Group 1: Electricity Savings

15% Savings on 500 PLN:

15% of 500 PLN = 75 PLN.

Monthly savings = 75 PLN.

60% of the bill during peak hours:

60% of 500 PLN = 300 PLN (bill during peak hours).

Calculate 15% savings from 300 PLN: 300 zł x 15% = 45 PLN.

Total Monthly Savings:

75 PLN (overall savings) + 45 PLN (peak hours) = 120 PLN.

Annual Savings:120 PLN × 12 months =1440 PLN
120PLN×12months=1440PLN.

Group 2: Store Discounts
1. Calculating the Bill with a 20% Discount on All Products:

Product A (400 PLN):

20% of 400 PLN = 80 PLN savings.

Price after discount: 400−80=320PLN
400−80=320PLN.

Product B (250 PLN):

20% of 250 PLN = 50 PLN savings.

Price after discount: 250−50=200PLN

Product C (150 PLN):

20% of 150 PLN = 30 PLN savings.

Price after discount: 150 − 30 = 120 PLN
150−30=120PLN.

2. Total Savings When Buying All Three Products with a 20% Discount

Savings:

Product A: 80 PLN

Product B: 50 PLN

Product C: 30 PLN

Total Savings: 80 + 50 + 30 = 160 PLN

80+50+30=160PLN.

Final Amount After Discount: 320 PLN + 200 PLN + 120 PLN = 640 PLN

320PLN+200PLN+120PLN=640PLN.

3. Calculating the Bill with Differentiated Discounts (30%, 20%, 10%)

Product C (150 PLN, 30% Discount)

30% of 150 PLN = 45 PLN savings.

Price after discount: 150 - 45 = 105 PLN
150−45=105PLN.

Product B (250 PLN, 20% Discount)

20% of 250 PLN = 50 PLN savings.

Price after discount: 250 −50 =200 PLN
250−50=200PLN.

Product A (400 PLN, 10% Discount)

10% of 400 PLN = 40 PLN savings.

Price after discount: 400 − 40 = 360 PLN

Comparison of Cost-Effectiveness:

Purchase with a Fixed 20% Discount:

Total Savings: 160 PLN

Final Amount to Pay: 640 PLN

Purchase with Varied Discounts (30%, 20%, 10%):

Total Savings: 135 PLN

Final Amount to Pay: 665 PLN

Group 3: Water Savings

30% Water Savings from 12 m^3:

30% of 12 m^3 = 3.6 m^3.

You will save 3.6 m^3 of water monthly.

Savings on the Bill:

3.6 m^3 x 10 PLN = 36 PLN savings per month.

Savings over 6 Months:

36 PLN x 6 = 216 PLN savings over 6 months.

-

Attachment No. 3 – Sample Bills for Analysis and Calculations

Task 1: Water Savings

Sample Monthly Water Bill:

Consumption: 14 m^3

Price per 1 m^3: 9 PLN

Monthly Bill: .... PLN

Sample Annual Consumption:

Annual Consumption: .... m^3

Annual Bill: .... PLN

Calculate Savings if You Reduce Water Consumption by 20%:

20% of 14 m^3 = ... m^3

New Monthly Consumption: .... m^3

New Annual Consumption: .... m^3 annually.

Calculate Savings on the Bill:

New Monthly Bill: .... PLN

New Annual Bill: .... PLN

Annual Savings: .... PLN

Additional Challenge: Increased Consumption During Drought:

Assume that during the drought period (July - August), the price of water increases by 15%. Calculate the new annual water bill (at the increased rate) if your consumption remains unchanged:

New Price per 1 m^3: .... PLN

New Monthly Bill During Drought: .... PLN

New Annual Bill (January - December): .... PLN

Difference Between the Original Bill and the New Bill: .... PLN

Task 2: Changing Electricity Provider

Sample Monthly Electricity Bill:

Consumption: 500 kWh

Price per 1 kWh: 0.85 PLN

Monthly Bill: .... PLN

Sample Annual Consumption:

Annual Consumption: .... kWh

Annual Bill: .... PLN

Task: Calculate Savings if You Switch to a Cheaper Energy Provider (8% Reduction):

New Price per 1 kWh: .... PLN (Calculate 8% reduction from 0.85 PLN)

New Monthly Bill: .... PLN (Calculate based on new price per kWh and consumption of 500 kWh)

New Annual Bill: .... PLN (Calculate for 12 months)

Annual Savings: .... PLN (Difference between original and new annual bill)

Calculate savings if you also invest in solar panels, which will reduce energy consumption by 25%:

New Monthly Consumption After Installing Solar Panels: .... kWh
New Monthly Bill: .... PLN
New Annual Bill: .... PLN
Annual Savings: .... PLN

Additional Challenge: Profitability of Investing in Solar Panels:
Cost of Solar Panel Installation: 12,000 PLN
Solar Panel Lifetime: 20 years

Calculate After How Many Years the Investment Will Pay Off:

Annual Savings: .... PLN
Payback Period: .... years

Task 3: Gas Savings

Sample Monthly Gas Bill:

Consumption: 150 m³

Price per 1 m³: 2.50 PLN

Monthly Bill: ………………………………… PLN

Sample Annual Consumption:

Annual Consumption: ………………………………… m³

Annual Bill: ………………………………… PLN

Task: Calculate Savings if You Reduce Gas Consumption by 12%:

12% of 150 m³ = ………………………………… m³

New Monthly Consumption: ………………………………… m³

New Monthly Bill: ………………………………… PLN

New Annual Bill: ………………………………… PLN

Annual Savings: ………………………………… PLN

Calculate Savings When Replacing the Boiler with a More Efficient One, Which Reduces Gas Consumption by an Additional 10%:

Additional Monthly Savings: 132 m³ x 10% = ………………………………… m³

New Monthly Consumption: ………………………………… m³

New Monthly Bill: ………………………………… PLN

New Annual Bill: ………………………………… PLN

Annual Savings (after replacing the boiler): ………………………………… PLN

Additional Challenge:

Consider How Climate Change Will Impact Future Energy Costs:

What will happen to your gas bill if gas prices increase by 20% in the coming years?

Conclusions for All Groups:

Ecological Conclusions for Task 1: Reducing water consumption by 20% can lead to annual savings of 302.40 PLN, and during periods of rising water prices (e.g., during a drought), these savings can be even greater.

Ecological Conclusions for Task 2: Switching energy providers and installing solar panels not only result in financial savings but also significantly reduce the consumption of grid electricity, which helps reduce CO_2 emissions and supports sustainable development.

Ecological Conclusions for Task 3: Reducing gas consumption by modernizing the boiler and adopting more mindful habits can save up to 936 PLN annually, while also reducing CO_2 emissions, which contributes to environmental protection.

These conclusions emphasize the benefits of implementing energy-saving measures, both financially and in terms of positive environmental impact.

Attachment No. 4 – Calculation Scheme for Your Own Bills

Electricity Calculation Scheme:

Current Energy Consumption:

Look at your electricity bill. Find the section that indicates energy consumption in kWh per month.

Record your monthly electricity consumption: ____ kWh

Record the price per 1 kWh: ____ PLN/kWh

Calculation of the Current Bill:

Monthly Consumption x Price per 1 kWh = Monthly Electricity Bill

Calculation: ____ PLN

Savings After Replacing Light Bulbs with Energy-Efficient Ones:

Assume that replacing all light bulbs in your home will reduce electricity consumption by 15%.

Monthly Savings Calculation:

Monthly Savings: ____ kWh

New Bill After Implementing Changes:

Calculate the new bill after replacing the light bulbs:

New Monthly Bill: ____ PLN

Annual Savings:

Calculate the average savings over the course of a year:

Annual Savings: ____ PLN

Water Calculation Scheme:

Current Water Consumption:

Look at your water bill. Find the monthly water consumption in m^3.

Record your monthly water consumption: ____ m^3

Record the price per 1 m^3: ____ PLN/m^3

Calculation of the Current Bill:

Monthly Consumption x Price per 1 m^3 = Monthly Water Bill

Calculation: ____ PLN

Calculation:

Current Monthly Bill: ____ PLN

Savings After Installing Aerators:

Assume that installing aerators reduces water consumption by 25%.

Calculate Monthly Savings: ____ m^3

New Bill After Implementing Changes:

Calculate the new bill after installing aerators:

New Monthly Bill: ____ PLN

Annual Savings:

Calculate the savings over the course of a year:

Annual Savings: ____ PLN

Gas Calculation Scheme:

Current Gas Consumption:

Look at your gas bill. Find the monthly gas consumption in m^3.

Record your monthly gas consumption: ____ m^3

Record the Price per 1 m^3:

Price per 1 m^3: ____ PLN/m^3

Calculation of the Current Bill:

Monthly Consumption x Price per 1 m^3 = Monthly Gas Bill

Calculation: ____ PLN

Savings After Changing Cooking Style:

Assume that changing the cooking style (e.g., cooking on lower heat, using lids) reduces gas consumption by 10%.

Calculate Monthly Savings: ____ m^3

New Bill After Implementing Changes:

Calculate the new bill after changing the cooking style:

New Monthly Bill: ____ PLN

Annual Savings:

Calculate how much you will save over the course of a year:

Annual Savings: ____ PLN

Attachment No. 5 – Tasks Related to Calculating What Percentage One Value Represents of Another

1. Cost of Water in the Household Budget

Annual water bill is 1440 PLN, and the annual household budget is 24,000 PLN.

Task: Calculate what percentage of the annual household budget the water bill represents.

2. Electricity Savings Compared to Total Energy Costs

Annual savings on the electricity bill after replacing light bulbs with energy-efficient ones is 400 PLN.

Annual energy costs in your home amount to 3600 PLN.

Task: Calculate what percentage of the total energy costs is represented by the savings from replacing light bulbs. Provide the result rounded to the nearest whole percentage.

3. Water Savings Thanks to Aerators

Task: Calculate what percentage of the previous water expenses this savings represents. Installing aerators has reduced the annual water cost by 240 PLN. The previous annual cost of water in your home was 1200 PLN.

4. Gas Savings Compared to Household Expenses

Annual savings after replacing the gas boiler amount to 350 PLN.

Total annual expenses on utilities (electricity, water, gas) are 5400 PLN.

Task: Calculate what percentage of the total utility expenses is represented by the savings on gas.

5. Reduction in CO_2 Emissions Compared to Total Energy Consumption

Solar panel installation has reduced CO_2 emissions by 2 tons annually.

Total emissions before installation were 8 tons.

Task: Calculate by what percentage the CO_2 emissions have decreased after installing the panels.

6. Impact of Replacing Household Appliances on Energy Consumption

A new energy-efficient washing machine and refrigerator have reduced energy consumption by 200 kWh annually.

The total annual energy consumption in your home was previously 5000 kWh.

Task: Calculate what percentage of the total energy consumption is represented by the savings after replacing household appliances.

7. Water Savings After Shortening Showers

Shortening daily showers saved 150 PLN annually on water. Previously, total annual water bills were 900 PLN.

Task: Calculate what percentage of the total water bills this savings represents. Provide the result rounded to the nearest whole percentage.

8. Heating Savings Thanks to Thermostat Installation

Installing a thermostat saves 500 PLN annually on heating. Previously, annual heating costs in your home were 2500 PLN.

Task: Calculate what percentage of the total heating expenses this savings represents.

9. Reduction in Water Consumption After Installing a Dishwasher

Installing a dishwasher reduced water consumption by 50 m^3 annually. Annual water consumption before installation was 250 m^3.

10. Savings After Lowering Heating Temperature
Lowering the heating temperature by 1°C reduced the heating bill by 10%. The annual cost of heating was 3000 PLN.
Task: Calculate the savings in PLN and what percentage of the total heating expenses this savings represents.

Answers to All 10 Tasks:

- Task 1: 6%
- Task 2: 11%
- Task 3: 20%
- Task 4: 6.48%
- Task 5: 25%jk
- Task 6: 4%
- Task 7: 17%
- Task 8: 20%
- Task 9: 20%
- Task 10: 10%

Scenario No. 3:

"Can you reduce the waste you produce?"

Workshop Objective:

To understand the concept of percentages and percentage points and how they apply to everyday situations such as bills, savings and survey results.

To reinforce the ability to calculate a percentage from a given value and improve accounting skills, which will help seniors manage their finances.

To increase awareness of the difference between percentages and percentage points.

To develop environmental awareness through 'small changes' in daily habits.

Duration: 3 hours

Materials required:

- Multimedia presentation - showing, among other things: data on the amount of waste produced annually, examples on the environmental impact of waste (soil pollution, water pollution, greenhouse gas emissions), consequences of excessive waste production and benefits of recycling.
- Annex 1: Interesting facts about waste and recycling, including data on energy, water and raw material savings.
- Annex 2: Instructions for calculating the volume of a cuboid with the formula $V = a \times b \times c$
- Annex 3: List of products that generate less waste and a practical task for reducing waste by 25%.
- Worksheets with tasks for mathematical calculations (estimating the volume of containers, reducing waste, converting units).
- Dry-erase boards and markers to record the results of group tasks and calculations.
- Calculators for each participant to perform calculations related to volume and percentages.
- Examples of waste containers (paper, plastic, bio, glass) - actual containers that participants will measure and analyse their volume.

Workshop schedule:

1. Introduction to the subject (discussion of the amount of waste produced annually by an average Pole, German and other EU countries, examples on the impact of waste on the environment (soil pollution, water pollution, greenhouse gas emissions), consequences of excessive waste production and benefits of recycling, practical steps to reduce waste in everyday life) - 20 minutes

Start by presenting data on the amount of waste produced.

According to Eurostat, the amount of municipal waste per person in the European Union in 2022 was. 513 kg. This is 4% less than in 2021, compared to 467 kg in 1995.

Municipal waste generation varied significantly between specific EU member states, with Austria (827 kg per person), Denmark (787 kg) and Luxembourg (720 kg) generating the most. At the other extreme is Romania (301 kg).

In the project partner countries, the amount of municipal waste per capita was 364 kg in Poland and 409 kg in Germany.

Treated waste is waste that is subjected to various forms of treatment so that it can be reused or neutralised in an environmentally safe manner. In the context of EU statistics, treated waste includes:

- Recycling - recovering raw materials from waste, e.g. paper, plastic, glass, metals, which can be reprocessed into new products.
- Composting and digestion - the biological conversion of organic waste (e.g. kitchen waste, green waste) into compost or biogas that can be used for soil fertilisation or as a source of energy.
- Incineration with energy recovery - incineration of waste during which thermal or electrical energy is recovered, helping to reduce the amount of waste going to landfill.

In 2021, on average, each inhabitant of the European Union generated 264 kg of recycled waste, showing a growing trend towards the use of more sustainable waste management methods. The countries leading the way in this statistic are Austria, Denmark and Germany, where efficient recycling and waste treatment systems are key to environmental protection.

Display Annex 1 to the group - in the form of a debate, discuss in turn:

- the consequences of excessive waste production and the benefits of recycling,
- examples on the environmental impact of waste (soil pollution, water pollution, greenhouse gas emissions),
- practical steps to reduce waste in everyday life.

Next, introduce the objectives of the workshop to the group - in particular focus on mathematical issues such as volume of solids, conversion of cubic units.

2 Theory and practical exercises (2.5 hours, including a break of 10 minutes)

2.1 Estimating the volume of waste containers (20 minutes)

Practical task: Exercise done in groups. Participants receive rectangular plastic or cardboard boxes imitating containers for renewable waste (e.g. plastic, paper, glass, metal). Groups also receive 'rubbish' - Different sized plastic bottles, glass bottles, milk cartons, cans.

They estimate how many cubic litres of waste will fit into each container (by putting the waste into the prepared containers) and then measure the dimensions of the containers (height, width, depth) and calculate the actual volume using the formula:

$V = a \times b \times c$

a - length, b - width, c - height of the container.

The task of the groups is to compare the results - estimated and calculated using the formulae.

The group with the most accurate estimate of the volume of the containers wins!

Recycling principles in Poland

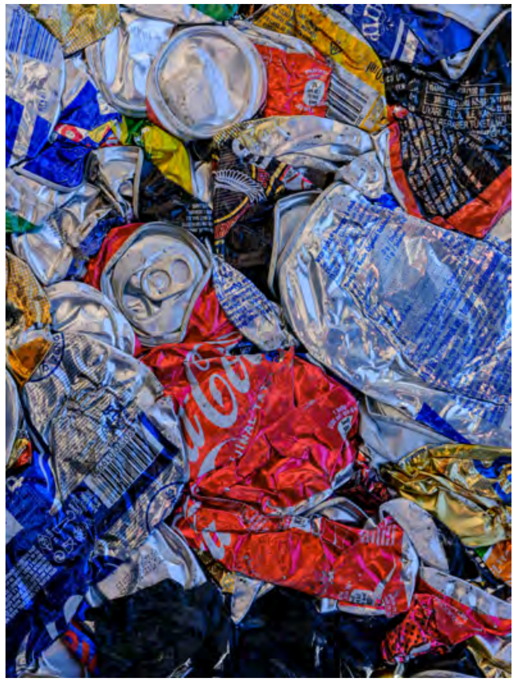
1. In Poland, the recycling system is based on the division of waste into five main categories, which should be segregated in the appropriate containers:

- Blue container - paper, including newspapers, cardboard boxes, notebooks, paper bags, food packaging. Used tissues, greasy packaging and waxed paper cannot be disposed of there.
- Green bin - glass, including bottles, jars and glass packaging. Heat-resistant glass, window glass, mirrors and ceramics cannot be thrown in here.
- Yellow bin - plastic and metal, including plastic packaging, metal cans, beverage cartons (tetrapacks). Do not throw in multi-material waste or used batteries and electronics.
- Brown bin - bio-waste including fruit peels, vegetable scraps, coffee and tea grounds, branches, leaves. Bones, meat, cooking oils and animal faeces may not be thrown in.
- Black bin - mixed waste, i.e. residual waste that cannot be recycled, e.g. hygiene waste (nappies, pads), greasy materials, used hygiene items

2. before being disposed of, packaging should be clean. Crushing plastic bottles and cartons saves space in the bins.

(3) Electronic waste and batteries must be collected separately, at special points or during dedicated collections.

4. bio-waste can also be composted in home composters, which is a great way to reduce waste and turn it into valuable fertiliser.



Recycling rules in Germany

Germany has one of the most developed recycling systems in the world. The country applies strict rules on waste separation, which translates into a high level of processing of secondary raw materials.

1. Multi-fraction system:

- Gelber Sack (yellow bag) - plastic packaging, cans, tetrapacks. Germany uses a returnable packaging system (depending on the type of packaging, the deposit can be recovered).
- Blaue Tonne (blue container) - paper and cardboard, similar to Poland, includes cardboard packaging, magazines, notebooks.
- Grüne Tonne (green container) - glass is divided into three categories - white, green and brown. It is important to separate glass by colour.
- Biotonne (brown bin) - bio-waste, including vegetable scraps, fruit peels, coffee grounds, plant residues. In some regions, this waste is collected in special biodegradable bags.
- Restmüll (mixed waste bin) - waste that cannot be recycled, e.g. food leftovers, used hygiene materials, packaging from dairy products, meat.

2. Deposit system (Pfandsystem) - Germany has a deposit system for plastic and glass bottles and cans. The customer pays an additional fee when buying a drink, which is recovered when the packaging is returned to the vending machine. This is one of the elements that makes the waste segregation system in Germany so effective.

3. regulations on electro-waste - in Germany, electronics recycling is strictly regulated and electro-waste can be returned to special collection points, which are mandatory in shops selling electronic equipment.

4. Strict penalties for failure to segregate - Germany places a strong emphasis on environmental education, and failure to comply with segregation rules can result in a fine. The monitoring system is strictly controlled by the municipalities.

When comparing waste separation systems in the partner countries, significant differences can be seen in both the organisation and effectiveness of recycling activities.

Germany is widely recognised as one of the leaders in waste management and recycling in Europe. The country has introduced a very sophisticated and complex segregation system that includes not only standard bins for paper, glass, plastic and biowaste, but also specific categories such as different colours of glass (green, white, brown), and a deposit system for bottles and cans (the so-called Pfandsystem). The system is very well organised and, thanks to extensive environmental education and harsh penalties for not separating, German citizens are aware of the need to take care of the environment. Around 67% of waste is recycled in Germany, making it one of the best in Europe in terms of recycling efficiency.

One of the key elements of the German system is the deposit system for bottles and cans. In practice, this means that when buying a drink in a plastic or glass bottle, the consumer pays an additional deposit, which can be recovered by returning the packaging to a vending machine. This encourages responsible packaging management and minimises the amount of rubbish ending up in landfill. Germany is also a pioneer in environmental education, which means that waste segregation is firmly entrenched in society and awareness of the benefits of recycling is very high.

In Poland, the waste segregation system, although still developing, is also becoming more and more developed. As in Germany, Poland has a five-fraction segregation system, including paper, glass, plastic, bio-waste and mixed waste. Segregation of waste in Poland is becoming more common, and local governments are introducing new initiatives to support recycling and reduce waste production.

One of the challenges facing Poland is the still relatively low level of recycling - according to 2022 data, it was 26.7. In comparison, Germany has a municipal waste recycling rate of over 60%, due to advanced infrastructure and legal support.

The differences in approach to waste management are also due to the level of investment in recycling infrastructure. Germany has invested heavily in the expansion of recycling facilities, the development of logistics systems and technology for processing secondary raw materials. Poland, while gradually increasing investment in modernising its waste management systems, still has a long way to go to reach the standards of countries such as Germany.

Despite these differences, Poland is experiencing an increase in environmental awareness, which, combined with the development of infrastructure, is allowing the share of recycled waste to gradually increase. Key for the future of the recycling system in Poland will be further investment in environmental education and infrastructure development, as well as the introduction of stricter segregation regulations.

In conclusion, Germany is a role model for Poland in the context of waste management. Germany's advanced recycling and sorting systems, as well as its strict regulations and high level of citizen involvement, demonstrate how environmental impacts can be effectively minimised through proper waste management. Poland has the potential to achieve similar results in the future, especially with further infrastructure development and the introduction of effective regulations.

As a conclusion, you could hold a discussion for the audience on how to improve the effectiveness of waste segregation.

2.2 Calculating how much space we could save (30 minutes)

Objective of the exercise:

Participants will be asked to calculate how recycling and reducing plastic consumption by 25% can reduce the volume of waste and save space in waste bins. The aim is to make participants aware that simple changes in daily habits can contribute to a significant reduction in the amount of waste generated, with a direct impact on environmental protection and better resource management.

Course of the exercise:

Brief introduction:

Discuss the importance of recycling in the context of waste reduction. Explanation of how much space is taken up by unsorted waste, including plastic, which is often problematic due to its volumetric properties (e.g. empty bottles take up a lot of space compared to their weight).

Introduce the concept of reducing the volume of waste by recycling and reducing plastic consumption by a certain percentage (in this case 25%).

Task 1: Calculating the space saved after waste reduction (10 minutes):

Participants are asked to calculate how much space they could save if they reduced their plastic production by 25%.

Example: A plastic container has a volume of 100 litres. By reducing the volume of plastic waste by 25%, participants are to calculate what the volume of waste will be after this reduction.

Calculation:

Reduction:

....

The final volume of waste after the reduction will be:

....

Task 2: Calculating the space saved by recycling (10 minutes):

Participants are given the task of calculating how much space can be saved if we recycle half of the plastic waste that would normally go to landfill.

Example: A container has a volume of 80 litres of plastic. Assume that 35% of the waste will be recycled.

Calculation:

Recycling:

....

Ultimately, the amount of waste going to landfill after recycling will be:

....

By solving the example, participants will see that recycling even part of the waste has a big impact on reducing the volume of waste that has to be landfilled or disposed of.

Task 3: Calculating the space saved over a month (10 minutes):

Participants calculate how much space can be saved by using waste reduction for one month. We assume that a household produces 120 litres of plastic waste per week.

Example: If a household reduces its plastic waste production by 25% each week, how many litres will it save in a month (4 weeks)?

Calculation:

Weekly reduction:

....

Monthly reduction:

....

Over the course of a month, the household will save .... litres of waste bin space.

As a brief conclusion, participants discuss the results of the calculations and consider how simple changes in daily habits, such as reducing plastic consumption and recycling, can lead to a significant reduction in waste generation. Pointing out that proper waste management not only helps to save space, but also has a positive impact on the environment.

2.3 Calculating the volume of waste per year (30 minutes)

Objective of the exercise:

Participants will learn how to calculate how much waste a household generates in a year and how many waste containers will be needed to store it. The exercise is designed to raise awareness about the volume of waste production and to encourage thinking about ways to reduce it.

Brief introduction:

The average Pole produces more than 350 kg of municipal waste each year. This equates to around 30 kg per month. It is important for us to understand how much space our waste takes up.

The standard waste container has a capacity of 120 litres. The maximum load of the container is 60 kg.

Participants will be asked to calculate how much waste one household produces in a year (Appendix 2). You can present an analogous task as an example before working in groups:

Assume that an average household consists of 4 people.

Calculation:

Annual waste = 350 kg × 4 persons = ... kg

Participants can discuss which specific sources of waste have the greatest impact on the total weight of waste, e.g. used food packaging, organic waste or plastic waste.

Number of bins = Annual waste/kg bin capacity (60 kg) = ...

This means that you will need .... waste bins to hold all the waste from one household for a whole year. Participants can also think about what would happen if the number of people in a household increased or decreased.

Workshop participants then work in groups - solving the tasks in Appendix 2, including:

- Participants calculate how many containers (60 kg) they will need to accommodate the annual waste from a household of ten people.

- If a household produces 1420 kg of waste per year and 40% of this waste is recycled, how many kg of waste goes to landfill?

- If the average resident produced 355 kg of waste in 2022, and this figure is expected to increase by 5% in 2023, how much waste will the average resident produce in 2023?

- Assume that of the waste produced by a household, 30% is recyclable waste. How many kg of waste is recyclable if we have a family of five? (Assume an average waste production of 350 kg per year per person).

- If a household produces 1200 kg of waste per year and organic waste accounts for 40% of all the waste produced by the family. By how many kilograms would the mass of waste produced be reduced if the household reduced organic waste by 10%? What percentage of the total waste is this? How many containers of waste (60 kg) would be saved?

- If the average cost of waste collection is 200 PLN per bin and the household consists of 5 people, how much is the waste collection bill per year? Is it worth adding a recycling service (one-off cost of 250 PLN) if it reduces the amount of waste produced by 15%?

- If recycling one tonne of paper saves 17 trees, and the household plans to recycle 15 tonnes of paper over 10 years, how many trees will they save? Furthermore, if each of these trees can absorb 22 kg of CO_2 per year during its lifetime, how much CO_2 will they save in total, taking into account the savings over 15 years?

Brief summary of the exercise - at the end, participants summarise their calculations and discuss what conclusions they have drawn from their accounts. Encourage them to reflect on how everyday waste management choices can affect their household budgets and the environment. Participants should understand that even small changes can lead to significant savings in terms of both space and resources.

2.4 Shopping awareness - group exercise (30 minutes)

Purpose of the exercise:

The aim of the exercise is to teach participants how their purchasing choices affect the amount of waste generated. Participants will analyse the products they buy and assess their impact on the environment.

Flow of the exercise:

Introduction (5 minutes):

Begin by discussing how everyday purchases contribute to waste generation. Emphasise that even small changes in purchasing choices can have a significant impact on reducing waste.

Groups are asked to assess which products on the list (Appendix 3) generate the most waste and which have environmentally friendly alternatives.

For example:

- Dairy - choosing yoghurt in a glass jar instead of plastic packaging.

- Vegetables and fruit - buying by weight instead of in disposable packaging.

Each group should summarise their findings, including examples of alternative products.

Summary (5 minutes):

Participants share their ideas for reducing waste in everyday shopping. You can emphasise the importance of a conscious approach to shopping to reduce the amount of waste generated.

2.5 Recycling and volume - group exercise (30 minutes)

Objective of the exercise:

Participants work together to calculate the volume of different wastes that could be recycled. The learners will understand how calculations affect the efficiency of waste management and learn which materials can be recycled efficiently.

Course of the exercise:

Introduction (5 minutes):

Start by emphasising the importance of recycling in environmental protection. Say: 'Correctly calculating the volume of waste is a key part of effective waste management. It allows us to better understand how much waste we produce and how we can reduce it.'

Explain that different materials take up different volumes, which affects the recycling process.

Task 1: Calculating volumes in groups (20 minutes):

Divide participants into groups of 4-5. Each group is to estimate the total volume of different wastes they could recycle in a week, based on the given data (Appendix 4), e.g.

Material:

Plastic packaging: 5 kg (occupying 0.01 m^3 for each kg).

Paper: 10 kg (occupying 0.003 m^3 for each kilogram).

Glass: 8 kg (occupying 0.002 m^3 for each kilogram).

Calculation:

Volume of plastic: $5\ kg \times 0.01\ m^3/kg = 0.05\ m^3$

Volume of paper: $10\ kg \times 0.003\ m^3/kg = 0.03\ m^3$

Volume of glass: $8\ kg \times 0.002\ m^3/kg = 0.016\ m^3$

Total volume: ...... m^3

Participants should also calculate how many containers they would have to use to store this volume, assuming that one container has a volume of 60 litres.

Task 2: Using the results (5 minutes):

Each group presents their results and discusses what materials they could recycle more effectively. They can also reflect on what changes in their daily shopping habits could reduce the amount of waste they produce.

Discussion (5 minutes):

After doing the calculations, each group discusses how the calculations affect their recycling choices. Encourage participants to think about what other materials they could recycle and what other benefits come from recycling, such as saving raw materials and energy.

3. End and evaluate the workshop (10 minutes)

Aim: To enable participants to reflect on the knowledge they have gained and to gather their feedback on the activities.

Short questionnaire to evaluate the activities - what information was most useful, what they would like to develop in the future.

Homework (to be completed by participants themselves):

- Choose a room in your house, measure its dimensions (height, width, length) and calculate its volume. Think about how you can optimise the use of this space.
- Measure the dimensions of several cardboard boxes (e.g. after shopping). Calculate their volume and compare which one is the largest. Consider what else they can be used for.
- Measure the volume of one of the bookcases in your house. What is the volume of all the books on the bookcase, assuming one book has a volume of 0.003 m^3?
- Identify all the containers you use to store waste in your home (e.g. containers for plastic, paper, glass, bio-waste). Measure their dimensions (height, width, length) and calculate the volume of each bin using the formula $V = a \times b \times c$. Write down how many bins of rubbish you fill per week/month. Think about the amount of waste you produce - give 5 ideas for minimising it.

Annex 1 - Environmental impact of waste and recycling

Consequences of excessive waste production

- Soil contamination - waste, especially waste that is not stored properly, can seep into the soil, introducing harmful chemicals. Examples include heavy metals from batteries or plastics, which can cause long-term contamination.

- Water pollution - a lot of waste, especially plastics, can end up in rivers and oceans, causing water pollution. Plastics, which take hundreds of years to decompose, pose a serious threat to aquatic ecosystems, affecting wildlife.

- Greenhouse gas emissions - the decomposition of waste in landfills emits methane and other greenhouse gases that contribute to global warming.

- Threat to biodiversity - waste, especially plastic waste, can pose a serious threat to biodiversity. Many organisms, both terrestrial and aquatic, are at risk of being eaten or entangled in waste. An example is seabirds, which often mistake plastic for food, leading to their death.

- Waste of natural resources - much of the waste that ends up in landfills could be recycled or reused. For example, according to data, recycling one tonne of paper saves around 17 trees and 38,000 litres of water.

- Health problems - excessive waste production can lead to health risks for people, especially if they come into contact with toxic substances in the waste. Chemicals can be found in landfill sites that can seep into groundwater and then into drinking water sources, posing health risks for residents

Benefits of recycling

1. Recovery of raw materials

Recycling allows materials to be reused, which reduces the need to extract natural resources. This reduces the exploitation of resources, which is crucial in terms of sustainability.

Example: Recycling one tonne of aluminium saves as much as 95% of the energy required to produce it from ore. Recycling paper, on the other hand, saves around 17 trees, 25,000 litres of water and a significant amount of energy.

2. Environmental protection

Recycling makes a significant contribution to reducing the amount of waste going to landfill, which improves air and soil quality.

The decomposition of waste in landfills emits methane and other greenhouse gases that contribute to global warming. Recycling helps to reduce these emissions.

3. Education and public awareness

Recycling increases public awareness of the environment. Participation in recycling programmes leads to greater awareness of environmental protection and the impact that consumption has on natural resources.

People who engage in recycling often become more aware of their purchasing choices, leading to a reduction in overall waste production.

Recycling not only benefits the environment, but also the economy.

Less waste sent to landfill can significantly reduce the costs associated with its management and disposal. In some regions, recycling costs are lower than landfill costs, which becomes economically beneficial for municipalities and local communities. Above all, however, waste reduction and efficient treatment can lead to significant savings in household budgets.

4. Employment growth

The recycling industry is becoming a significant source of employment.

Statistics:

In the European Union, the recycling sector generates hundreds of thousands of jobs. Every thousand tonnes of recycled waste can create between 1 and 1.17 more jobs than traditional waste management methods.

Practical steps to reduce waste in everyday life

- Using an effective waste separation system allows for better recycling. It is important to understand what materials can be recycled.

- Choosing reusable products such as shopping bags, bottles or containers can significantly reduce waste.

- Making a shopping list and avoiding impulse purchases helps minimise food waste and reduces waste.

- Regularly informing yourself and others about the importance of recycling and reducing waste is key to making sustainable changes in environmental behaviour.

Debate

Based on the above information, encourage participants to discuss:

What are the environmental consequences of excessive waste production?

What are the benefits of recycling?

What simple steps can each of us take to reduce the amount of waste produced in our daily lives?

Summary

Encourage participants to reflect on their personal habits and what changes they can make to help protect the environment by reducing waste.

Annex 2 - Amount of waste generated by the household

1. Calculating the number of containers for a ten-person household

Task: Participants calculate how many 60 kg containers they will need to accommodate the annual waste from a ten-person household.

Steps:

Step 1: Calculate the annual waste for a ten-person household:

Annual waste = average production per person × number of people

…………………………………………………………..

…………………………………………………………..

Step 2: Calculate the number of containers:

Number of containers = Annual waste ÷ Maximum container load (60 kg).

……………………………………………………………

……………………………………………………………

Number of containers:

…………………………………………………………… (rounding up).

2. Calculating waste to landfill

Task: A household produces 1420 kg of waste per year and 40% of this waste is recycled. How many kg of waste goes to landfill?

Steps:

Step 1: Calculate the amount of waste recycled:

……………………………………………………………

……………………………………………………………

Step 2: Calculate the waste going to landfill:

Waste to landfill = Total waste - Waste recycled.

....

....

3. Forecast for the future

Task: If the average resident produced 355 kg of waste in 2022, and this figure is predicted to increase by 5% in 2023, how much waste will the average resident produce in 2023?

Steps:

Step 1: Calculate the increase in waste:

Increase = ... kg

Step 2: Calculate the total waste production in 2023:

Waste in 2023 = 355 kg + ... kg = ... kg

Rounding up, the average resident will produce approximately .... kg of waste.

4. Calculation of recyclable waste

Task: Assume that of the waste produced by a household, 30% is recyclable waste. How many kg of waste is recyclable in a family of five?

Steps:

Step 1: Calculate the annual waste production for a family of five:

Annual waste = 350 kg × 5 = ... kg.

Step 2: Calculate the recyclable waste:

Recyclable waste = ... kg × 0.30 = ... kg.

5. Reducing the weight of organic waste

Task: If a household produces 1200 kg of waste per year and organic waste accounts for 40% of all the waste produced by the family. By how many kilograms would the mass of waste produced be reduced if the household reduced organic waste by 10%? What percentage of the total waste is this?

Steps:

Step 1: Calculate the amount of organic waste:

Organic waste = ... kg.

Step 2: Calculate the reduction in organic waste:

Reduction = ... kg.

Step 3: Calculate new amount of organic waste:

New amount of organic waste = ... kg.

Step 4: Calculate the percentage reduction against all waste:

.... %

6. Costs of waste collection

Task: If the average cost of waste collection is £200 per bin and a household consists of 5 people, how much is the waste collection bill per year? Is it worth adding a recycling service (one-off cost of £250) if it reduces the amount of waste generated by 15%?

Steps:

Step 1: Calculate the annual waste for a family of five:

Annual waste = 350 kg × 5 = ... kg.

Step 2: Calculate the number of containers needed to store the waste:

Number of containers = 1750 kg ÷ 60 kg = ...

Rounding up, you will need .... containers.

Step 3: Calculate the annual cost of disposal:

Cost of collection = ... containers × 200 PLN = ... PLN.

Step 4: Calculate the savings from recycling:

Number of waste after reduction = ... kg × 0.15 = ... kg.

Cost of disposal after recycling = ... kg = 24.58, which rounds up to .... containers.

Cost after recycling = ... containers × 200 PLN = ... PLN.

Step 5: Cost comparison:

Cost of recycling = ... PLN.

Savings = ... PLN.

7. Savings from paper recycling

Task: If recycling one tonne of paper saves 17 trees, and the household plans to recycle 15 tonnes of paper in 10 years, how many trees will they save? Furthermore, if each of these trees can absorb 22 kg CO_2 per year during its lifetime, how much CO_2 will they save in total, taking into account the savings over 15 years?

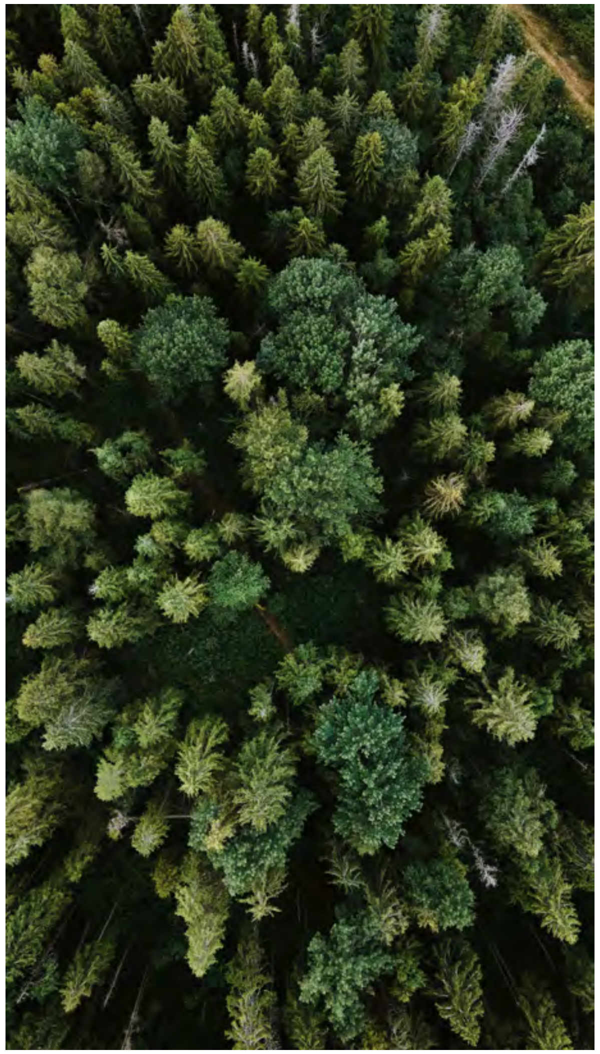
Steps:

Step 1: Calculate the number of trees saved:

Trees saved = 15 tonnes × 17 trees/tonne = ... trees.

Step 2: Calculate CO_2 saved:

Total CO_2 saved = ... trees × 22 kg CO_2/tree × 15 years = ... kg CO_2.



Annex 3 - Environmentally friendly products and alternatives

List of waste generating products and their environmental alternatives

Dairy products
Product: Yoghurt in plastic packaging
Environmentally friendly alternative: Yoghurt in a glass jar

Product: Milk in a plastic carton
Milk in a glass bottle

Product: Cheese in plastic packaging
Environmentally friendly alternative: Cheese in paper or wax packaging

Vegetables and fruit
Product: Vegetables in disposable packaging
Environmentally friendly alternative: Purchase by weight without packaging

Product: Fruit in plastic baskets
Environmentally friendly alternative: Fruit in bulk or in biodegradable bags

Drinks
Product: Carbonated soft drink in a plastic bottle
Environmentally friendly alternative: Drink in a glass bottle or from the tap

Product: Juice in a plastic carton
Environmentally friendly alternative: Freshly squeezed juice in a reusable bottle

Snacks
Product: crisps in plastic packaging
Environmentally friendly alternative: Nuts in a paper bag

Product: Bars in plastic packaging
Environmentally friendly alternative: Homemade candy bar made from natural ingredients

Household chemicals
Product: Cleaning products in plastic bottles
Environmentally friendly alternative: Cleaning products in reusable packaging

Product: Washing powder in plastic packaging
Environmentally friendly alternative: Powder in paper packaging or pouches

Cosmetics
Product: Shampoo in a plastic bottle
Environmentally friendly alternative: Shampoo in a bar or glass bottle

Product: Shower gel in a plastic bottle
Environmentally friendly alternative: Bar gel or natural soap in a glass container

Eating out
Product: Meals in plastic containers
Environmentally friendly alternative: Meals in reusable containers

Product: Plastic straws
Environmentally friendly alternative: Paper or reusable straws

Instructions for groups

Product analysis:

- Go through the list above and choose a few products that you often buy.

- Consider what alternatives you could replace them with (give other alternatives).

Conclusions:

- Each group summarises their conclusions and gives examples of alternative products that are more environmentally friendly.

- For example, if you choose yoghurt in plastic packaging, consider buying yoghurt in a glass jar instead.

Discussion:

- Share your ideas for reducing waste in your daily shopping.

- Consider what specific actions you can take to reduce the amount of waste you produce.

Annex 4 - Calculation of waste volumes for recycling

Task: Calculation of the volume of waste generated by the household

Task objective: Participants will estimate the total volume of different wastes they could recycle in a week and calculate how many containers they would need to store them.

Data provided:

Material	Weight (kg)	Volume (m^3/kg)
Plastic bags	6 kg	0.015 m^3/kg
Beverage cartons	5 kg	0.004 m^3/kg
Glass (bottles)	7 kg	0.003 m^3/kg

Volume calculation for each material:

Plastic bags:

.... m^3

Beverage cartons:

.... m^3

Glass (bottles):

.... m^3

Total volume:

.... m^3

Number of containers (Assuming one container has a capacity of 60 litres (i.e. 0.06 m^3), calculate how many containers will be needed:):

....

....

Once the calculations are done, each group presents their results and discusses what steps they can take to increase the amount of waste recycled. Participants can also reflect on how the calculations affect their recycling choices.

Scenario No. 4:

"Do you know how much smog costs?"

Workshop objective:

- Raising awareness among participants about the costs and consequences of air pollution and its carbon footprint.
- Developing mathematical skills through calculating the costs of the carbon footprint in daily life.
- Analyzing statistical data and estimating percentages in the context of transportation.

Duration: 3 hours

Required materials:

- Whiteboards and markers for recording group task results and calculations.
- Calculators for each participant to perform percentage-related calculations.
- Attachment No. 1: Presentation on smog – its causes, effects, and impact on health and the economy.
- Attachment No. 2: CO_2 emission calculations for various means of transport.
- Attachment No. 3: Analysis of the number of cars and the carbon footprint in Poland and Germany.
- Attachment No. 4: Comparison of household carbon footprints in Poland and Germany, considering traditional and energy-efficient houses.
- Attachment No. 5: Calculation of CO_2 emission and cost savings when switching to public transport.
- Attachment No. 6: Carbon footprint calculations for group travel – analysis of differences between air and land travel for 20 people.

Workshop Plan:

1. Introduction to the Workshop Topic (20 minutes)

Presentation: Discussion of the concept of smog, its causes, and its effects on health and the economy (Attachment No. 1). Use examples such as PM2.5 and PM10 particle pollution and their long-term effects on the environment and health.

Discussion: A brief exchange of opinions on personal observations related to air quality. Participants can share their experiences regarding the impact of smog in their region.

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Calculating the carbon footprint for different means of transport (30 minutes) – group work

Participants, divided into groups, analyze data on CO2 emissions from various means of transport (airplanes, cars, bicycles, public transport). They calculate how many kilograms of CO2 are generated by annual travel using different modes of transport over a distance of 15,000 km and what this amounts to when converted to monthly usage (Attachment No. 2).

Mathematical Objective: Percentage calculations and unit conversion of CO2 emissions.

2.2. Comparison of the number of cars and the carbon footprint in Poland and Germany (30 minutes) – individual work

Participants receive statistical data on the number of cars per 1,000 inhabitants in Poland and Germany, as well as the average carbon footprint generated by vehicles (Attachment No. 3).

The task for participants is to calculate the total CO2 emissions in each country and analyze the percentage difference between them.

After the exercise, you may lead a discussion on green forms of transport and the impact of their use on the environment.

2.3.Household carbon footprint (20 minutes) – group work based on participants' own bills

Participants calculate the carbon footprint from household energy consumption based on electricity usage using average CO_2 emission data per kWh in partner countries.

Percentage comparison of energy consumption in traditional and energy-efficient homes in Poland and Germany (Attachment No. 4).

2.4. Impact of switching to public transport (20 minutes) – individual work

Workshop participants are tasked with calculating the savings in CO_2 emissions and costs for an individual who switches from using a car to public transport over a week, month, and year (Attachment No. 5).

Mathematical Objective: Estimating percentage savings and converting costs into zlotys/euros.

2.5. Calculating the carbon footprint of air travel (20 minutes) – group work

Participants, working in groups, calculate the carbon footprint of air travel over a distance of 1,000 km (the distance they had to cover for the transnational mobility trip from Gdynia to Bad Freienwalde and back to Gdynia) and compare it with the carbon footprint of land transport on the same route (carpooling, low-emission coach).

The task for the groups is to calculate the CO_2 savings when using different forms of transport. Groups work with Attachment No. 6.

Mathematical Objective: Percentage comparison and statistical data analysis.

2.6. Impact of meat consumption on the carbon footprint (20 minutes) – group work

Participants, working in groups of three, calculate the carbon footprint associated with meat production compared to plant-based food production. They analyze data on CO2 emissions per kilogram of various products (Attachment No. 7).

Mathematical Objective: Percentage comparison and calculations related to the environmental impact of diet.

3. Conclusion and workshop evaluation (10 minutes)

Objective: Allow participants to reflect on the knowledge gained and collect their feedback on the session.

A brief evaluation survey of the workshop – identifying the most useful information and what they would like to explore further in the future.

Homework (for participants to complete individually):

Data analysis on PM2.5 standards

Participants receive worksheets with a brief introduction to data from airly.org, an explanation of what PM2.5 standards mean, and the consequences of exceeding these standards for health and the environment (Attachment No. 8).

Participants gain access to airly.org data on the number of days with PM2.5 standard exceedances in various provinces of Poland.

Participants are tasked with identifying in which months exceedances were most frequent and attempting to infer the causes of these phenomena (e.g., weather conditions, increased vehicle traffic, heating seasons).

Based on the obtained data, participants calculate what percentage of days in the year were days with PM2.5 standard exceedances for each province.

In the next workshop, a discussion takes place where participants compare results and present their conclusions.

Attachment No. 1 – Presentation on Smog

Smog – its causes, effects, and impact on health and the economy

What is smog?

Smog is a type of air pollution that results from the combination of various industrial emissions, vehicle exhaust, suspended particles, and other pollutants with natural atmospheric conditions, such as fog. The most well-known types of smog are London smog (sulfur type) and photochemical smog (carbon type), each of which forms under different atmospheric conditions and has distinct health effects.

Main components of smog:

- Suspended particles PM10 and PM2.5 – particles with diameters smaller than 10 and 2.5 micrometers, respectively, which can penetrate the lungs and bloodstream, causing a range of health problems.
- Nitrogen and sulfur oxides – gases emitted from vehicle exhausts and industry, contributing to the formation of acids in the atmosphere that, when deposited on the ground, damage ecosystems.
- Tropospheric ozone – a gas formed by the reaction of pollutants with solar radiation, which is highly irritating to the respiratory tract.

Health effects of smog:

- Respiratory diseases – asthma, chronic obstructive pulmonary disease (COPD), bronchitis.
- Cardiovascular problems – increased risk of heart attacks and strokes.
- Impact on the immune system and child development – lower immunity, lung development issues in children.

Economic effects of smog:

- Health costs – increased spending on the treatment of diseases caused by air pollution, higher number of work absences.
- Reduced work efficiency – health problems among workers can lead to decreased productivity.
- Environmental degradation – reduced biodiversity, soil and water degradation, impacting agriculture and tourism.

Discussion:

Participants share their own observations regarding air quality in their regions and discuss the local impacts of smog – on health, the economy, and tourism.

Reflection on actions – a conversation on what can be done individually and as a community to reduce air pollution levels.

Attachment No. 2 – Calculating the carbon footprint for different means of transport

What is a carbon footprint?

A carbon footprint is a measure of the total amount of greenhouse gases, such as carbon dioxide (CO_2) and methane (CH_4), emitted directly and indirectly by the activities of an individual, organization, event, or product. This value is usually expressed in carbon dioxide equivalents (CO_2e), which allows different types of greenhouse gases to be included in a single common metric. The carbon footprint is a key indicator of climate impact and is used to assess and manage this impact at the local, national, and global levels.

Poland – the carbon footprint per person in Poland is relatively high compared to the European average, mainly due to the heavy reliance on coal for electricity production. Greenhouse gas emissions in Poland per capita amounted to 11 tons per resident in 2022. This is a worse result than the EU average (8.1 tons) and the fifth worst in the entire EU. Germany has a carbon footprint of around 9 tons of CO_2e per person annually, which also exceeds the EU average. High emissions in Germany are partly related to intensive industrial activity. However, Germany is also a leader in low-emission technology and renewable energy sources, which helps reduce its overall carbon footprint.

Scandinavian countries often have lower carbon footprints due to investments in renewable energy and environmental policies, while Eastern European countries tend to have higher carbon footprint values.

The carbon footprint is crucial in the fight against climate change. Reducing the carbon footprint at the individual, corporate, and national levels can significantly contribute to achieving climate goals, such as limiting global warming to below 2°C in accordance with the Paris Agreement. Reducing CO_2 and other greenhouse gas emissions can be achieved through changes in energy production and consumption, transportation, industry, and waste management.

Participants, working in groups, analyze data on CO_2 emissions from various means of transport and calculate the environmental impact of their annual and monthly use. The distance considered for analysis is 15,000 km per year, which corresponds to the average annual travel distance.

Data for the task:

- Cars (gasoline):
  CO_2 emissions: 192 g/km
  Typical fuel consumption: 8 l/100 km

- Airplanes (domestic flights):
  CO_2 emissions: 254 g/km
  Consideration of the high impact of emissions at high altitudes

- Bicycles:
  CO_2 emissions: 0 g/km
  Consideration of a minor impact from the production and maintenance of bicycles

- Public transport (city buses):
  CO_2 emissions: 101 g/km
  Fuel efficiency of city buses

- Electric cars:
  CO_2 emissions: 0 g/km from the vehicle
  Consideration of emissions from electricity production (dependent on the energy source)

Annual calculations:

Participants are tasked with calculating the total CO_2 emissions for each mode of transport based on the provided data, for an annual distance of 15,000 km.
Example calculation for a gasoline car:
15,000 km × 192 g/km = 2,880,000 g = 2,880 kg

Monthly calculations:

Next, participants convert the annual CO_2 emissions into monthly values by dividing the annual emissions by 12.
Example monthly calculation:
2,880 kg ÷ 12 = 240 kg

Percentage analysis:

Participants calculate the percentage share of each mode of transport in the total emissions, which allows for a comparison of their environmental impact.

Step 1: Calculate the total CO_2 emissions for each mode of transport

Participants must first calculate the total amount of CO_2 emitted by each mode of transport based on the data provided in the attachment, for an example annual distance of 15,000 km.

Step 2: Sum the total emissions

Add all the calculated CO_2 emission values to obtain the total annual CO_2 emissions.

Step 3: Calculate the percentage share of each mode of transport

Divide each individual emission value by the total emissions, then multiply the result by 100 to get the percentage share.

Additional task:

Analysis of the impact of changing modes of transport
Groups will experiment with different scenarios, e.g., switching 50% of car travel to public transport or cycling, and calculate the new total CO_2 emissions.
These calculations help understand what real environmental benefits can be achieved by changing transport habits.

Discussion and reflection

After the calculations, hold a group discussion on the results obtained.
Participants compare which mode of transport is the most and least harmful to the environment. They consider what changes in transport habits they could implement to reduce their carbon footprint.

Attachment No. 3 – Comparison of the Number of Cars and Carbon Footprint in Poland and Germany

Data for the task:

For the purpose of the task, assume the number of cars per 1,000 inhabitants is:

– 700 cars in Poland,
– 560 cars in Germany.

An interesting fact is that in Poland, there are 703 cars per 1,000 inhabitants – the highest in the entire EU. Poland is the leader in the number of cars per 1,000 inhabitants. In Germany, there were 561 cars per 1,000 inhabitants, in France – 478, and the lowest number was in Hungary – 355.

According to the European Environment Agency, approximately 1/4 of total CO_2 emissions in the EU in 2019 came from the transport sector, with 71.7% from road transport. As part of efforts to reduce CO_2 emissions and to achieve climate neutrality by 2050, in line with the European Green Deal, we must reduce greenhouse gas emissions by 90% by 2050 compared to 1990 levels.

Average CO_2 emissions per car per year (in kg CO_2/year):

Poland: 2,000 kg CO_2

Germany: 1,800 kg CO_2

Population (in millions):

Poland: 38 million

Germany: 83 million

Task Instructions:

Step 1:

Calculate the total number of cars in each country:

Poland:

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Germany:

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Step 2:

Calculate the total annual CO_2 emissions for each country:

Poland:

…………………samochodów × 2000kg CO_2=

…………………………………………………………………

Niemcy:

…………………number of cars × 2,000 kg CO_2 =

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Step 3:

Calculate the percentage difference in CO_2 emissions between the countries:

Calculate the difference in emissions:

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Calculate the percentage difference relative to the smaller value:………………………………………………………

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Discussion:

Consider why there may be differences in CO2 emissions despite different numbers of cars per capita. It is worth noting factors such as differences in car technology, environmental regulations, or the popularity of green forms of transport.

Discussion on how increasing the share of green forms of transport (e.g., electric cars, carsharing, public transport) could impact the reduction of CO2 emissions in both countries.

Attachment No. 4 – Household Carbon Footprint

Participants are tasked with calculating the carbon footprint of their household based on electricity consumption and comparing how the carbon footprint changes with the use of energy-efficient technologies.

Data for the task:
Average CO_2 emissions per kWh:

Poland: 0.7 kg CO_2/kWh

Germany: 0.4 kg CO_2/kWh

According to data collected by Our World In Data, in 2021, each kilowatt-hour of energy produced in Poland resulted in 657.1 grams of CO_2 emissions into the atmosphere.

Average annual electricity consumption in a household:

Traditional household: 4,000 kWh

Energy-efficient household: 2,400 kWh

Calculate the carbon footprint for a traditional household:

Poland:

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Germany:

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Calculate the carbon footprint for an energy-efficient household:

Poland:

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Germany:

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Percentage comparison:

Calculate how much smaller the carbon footprint of an energy-efficient household is compared to a traditional one.

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Group discussion

Impact of energy-efficient technologies on the carbon footprint

Participants discuss in groups how technologies such as thermal insulation, energy-efficient windows, energy-saving household appliances, and heating systems can reduce the carbon footprint. They consider the potential benefits of greater adoption of energy-efficient technologies in households.

Incentives and barriers for energy efficiency

They discuss what "incentives" (e.g., tax breaks, grants, informational programs) are available in Poland and Germany to promote energy-efficient homes.

Consider the barriers that may hinder the transition to energy-efficient solutions, such as initial costs, lack of awareness, or limited availability of technology.

Attachment No. 5 – Impact of Switching to Public Transport

Participants are tasked with calculating the CO_2 emission savings and costs associated with switching from using a car to public transport. The analysis should cover different time periods: a week, a month, and a year.

Data for the task:

Average CO_2 emissions from a car: 192 g/km

Average fuel cost: 5.50 PLN/l or 1.50 EUR/l

Average fuel consumption of a car: 7 l/100 km

Average distance traveled by car:

Weekly: 150 km

Monthly: 600 km

Annually: 7,200 km

Cost of a monthly public transport pass: 180 PLN or 70 EUR

Task Instructions:

Calculate the annual, monthly, and weekly CO_2 emissions from car usage:

Weekly:

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Monthly:

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Annual:

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Calculate the annual, monthly, and weekly CO_2 emissions from using public transport:

Weekly:

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Monthly:

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Annual:

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Calculate CO_2 savings when switching to public transport:

Weekly, monthly, annually – the difference between emissions from using a car and public transport.

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Calculate the costs of using a car and compare them with the costs of public transport:

Fuel costs weekly, monthly, annually (considering average fuel consumption and fuel price).

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Compare with the costs of a monthly public transport pass calculated per week, month, and year.

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Percentage comparison of savings:

Calculate the percentage difference in costs and CO_2 emissions between both forms of transport...

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Discussion:

Participants discuss the results of their calculations, considering the feasibility and benefits of switching to public transport.

Discussion on potential incentives for using public transport and the barriers that might prevent people from changing their habits.

Attachment No. 6 – Calculations of the Carbon Footprint of Air and Land Travel

Participants are tasked with calculating the carbon footprint of a group flight and comparing it to the carbon footprint of land transport (carpooling, low-emission coach) for 20 people over a distance of 1,000 km. The goal is to identify CO_2 emission savings when using different forms of transport.

Data for the task:

Travel distance: 1,000 km

CO_2 emissions per kilometer for various modes of transport:

Airplane: 254 g CO_2/km per passenger

Carpooling (3 people in a car): 104 g CO_2/km (total for the car)

Low-emission coach: 27 g CO_2/km per passenger

Task Instructions:

Calculate the carbon footprint for air travel for 20 people:

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Calculate the carbon footprint for carpooling for 20 people:

Number of cars needed (with 3 people per car):

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CO_2 emissions per car for 1,000 km:

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Total CO_2 emissions for 7 cars:

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Calculate the carbon footprint for a low-emission coach for 20 people:

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Compare CO_2 emissions from different modes of transport for 20 people:

Calculate the difference in CO_2 emissions between air travel and each type of land transport.

Express the difference as a percentage reduction in CO_2 emissions.

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Savings analysis – participants analyze which form of transport is the most efficient in terms of CO_2 emissions per person and why.

Discussion:

Groups discuss how the choice of transport affects the environment, especially in the context of climate change and a large number of travelers.

They consider alternative travel scenarios that could further reduce CO_2 emissions, such as using electric cars for carpooling or even more efficient coaches.

Attachment No. 7 – Impact of Meat Consumption on the Carbon Footprint

Participants work in groups of three to calculate and compare the carbon footprint associated with meat production and plant-based food, analyzing data on CO_2 emissions per kilogram of various products. The goal is to understand the environmental impact of diet.

Data for the task: CO_2 emissions per kilogram of product:

Beef: 27 kg CO_2e/kg

Poultry: 6.9 kg CO_2e/kg

Pork: 12.1 kg CO_2e/kg

Tofu: 2 kg CO_2e/kg

Legumes (e.g., beans): 0.4 kg CO_2e/kg

Task Instructions:

Calculate the total carbon footprint for each product:

Each group calculates the annual consumption for a typical family (2 adults, 2 children), assuming the average meat consumption is 50 kg per person per year (10 kg of beef, 20 kg of poultry, 20 kg of pork), and the consumption of plant-based food (tofu and legumes) is a total of 40 kg (10 kg of tofu, 30 kg of legumes) per person per year.

Calculate the total carbon footprint for the family resulting from the consumption of these products :

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Compare both totals and calculate the percentage difference in emissions between the meat-based diet and the plant-based diet.

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Analysis:

Participants analyze the environmental impacts of choosing a meat-based diet compared to a plant-based diet. They discuss potential changes in dietary habits that could help reduce the carbon footprint.

Discussion:

Impact of diets on the environment – groups discuss the impact of meat consumption compared to plant-based products on climate change. They consider what actions could encourage society to reduce meat consumption and increase the share of plant-based products in their diet.

Attachment No. 8 – Homework

Data Analysis on PM2.5 Standards

Participants complete their homework by analyzing data on PM2.5 standard exceedances in various provinces of Poland to understand how often and under what circumstances these exceedances occur, as well as the potential consequences for health and the environment.

Materials:

Worksheets: Containing a brief introduction to the issue of PM2.5, information on standards, and the consequences of exceedances for health and the environment.

Data from airly.org: Participants gain access to current data on the number of days with PM2.5 standard exceedances in various provinces of Poland.

Tasks to Complete:

Data Analysis:

Participants analyze the available data and identify the provinces with the highest number of days exceeding PM2.5 standards.
The task is to determine in which months the exceedances were most frequent.

Inferring Causes:

Based on the data analysis, participants are tasked with inferring possible reasons for the increased exceedances during those months (e.g., weather conditions, increased vehicle traffic, heating periods).

Percentage Calculations:

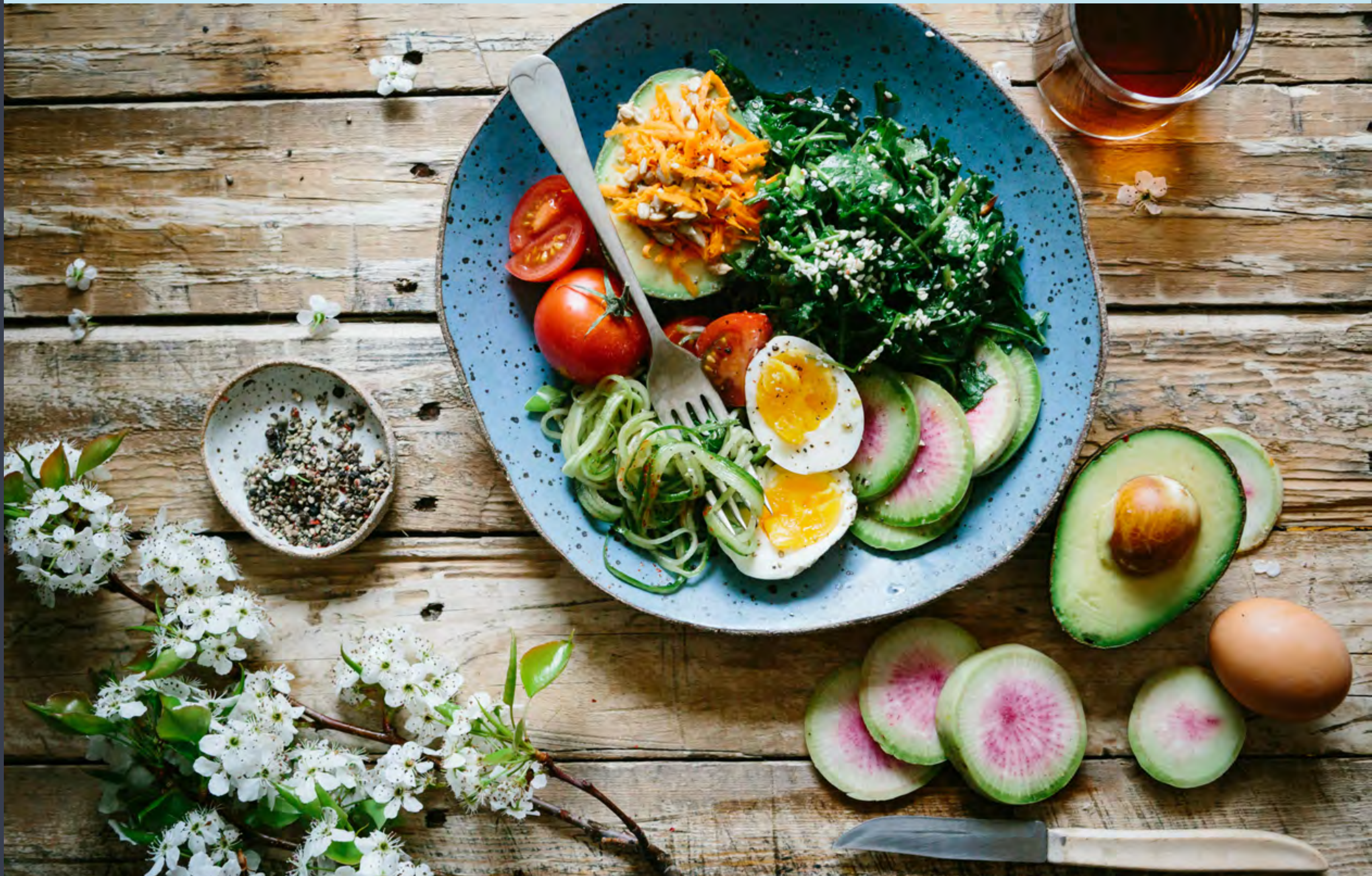
Participants calculate what percentage of days in the year were days with exceedances of the PM2.5 standards for the selected provinces.

Preparation for Discussion:

Participants prepare presentations of their findings, which will be presented and discussed in the next workshop.

Scenario No. 5

"Is switching to vegetarianism "worth it"?"



Workshop Goal:

Understanding the Impact of Diet on Finances and the Environment – Participants will understand how switching from a meat-based diet to a vegetarian one can affect their personal finances by analyzing percentage differences in expenses. Additionally, they will learn how dietary choices influence CO_2 emissions and, consequently, contribute to climate change and the health of the natural environment.

Learning Basic Mathematics in Practice – Participants will grasp the difference between percentage and percentage points, understanding how these concepts are applied in everyday situations such as analyzing expenses, price changes, or evaluating financial results. They will also learn methods for calculating percentages and their practical applications, empowering them to manage their household budgets more consciously.

Mastering Unit Conversion and Currency Exchange Rates – Participants will learn to convert units accurately to analyze differences in consumption and CO_2 emissions associated with meat-based versus vegetarian diets.

Additionally, participants will learn how to calculate costs associated with purchases in different currencies, which is useful for planning grocery shopping from international markets or during travel.

Duration: 3 hours

Required Materials:

- Additional Required Materials:
- Dry-erase boards and markers for recording group task results and calculations
- Calculators for each participant for performing percentage-related calculations
- Attachments:
- Attachment No. 1: Environmental Impact of Meat Production
- Attachment No. 2: Calculating the Carbon Footprint of Meat Consumption
- Attachment No. 3: Cost Analysis of Diets
- Attachment No. 4: CO_2 Emission Reduction Through Dietary Change
- Attachment No. 5: Currency Exchange Rate Conversion
- Attachment No. 6: Calculating Percentage Points in Food Expenses
- Attachment No. 7: Price Change Simulation and Its Impact on Budget
- Attachment No. 8: Nutritional Value Analysis of Diets

Workshop Plan:

1. Introduction to Workshop Topics (20 minutes)

Presentation: Discussion of the environmental impact of meat production in the following categories – CO_2 and other greenhouse gas emissions, water usage, land degradation, and biodiversity loss (Attachment No. 1).

Discussion: A brief exchange of opinions on personal observations related to meat consumption – estimates of annual meat consumption in the country, and whether these are lower or higher than the European average. Participants may share their experiences regarding meat consumption in their households.

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Calculating the Carbon Footprint of Meat Consumption – Individual Work (20 minutes)

Participants are tasked with calculating the annual CO_2 emissions related to meat consumption in Europe, Poland, and Germany – working with Attachment No. 2.

Next, they calculate the changes in CO_2 emissions that would occur with a 15% and 40% reduction in meat consumption.

Begin the exercise with an introduction – According to a report by Strategy & Poland, the average Polish person consumed 73.2 kg of meat in 2022 – over 4 kg more than the average resident of OECD countries and more than 5 kg more than the average EU resident. In contrast, data from the German Federal Statistical Office shows that in 2020, meat consumption in Germany was 57.3 kg per capita.

2.2. Diet Cost Analysis – Group Work (20 minutes)

Participants, divided into groups (3-4 people each), will compare the monthly costs of a meat-based diet with a vegetarian diet, assessing potential savings as well as the long-term financial and health impacts of switching to a plant-based diet.

Each group receives a dataset on food costs (meat and vegetable prices), average monthly consumption, and associated CO_2 emissions (Attachment No. 3). Groups will calculate the monthly cost of a meat-based and a vegetarian diet, the cost difference, potential savings from switching to a plant-based diet, and the percentage difference in costs between the two diets.

Next, groups will analyze potential savings over one year and five years, factoring in possible food price increases. Participants will also discuss the long-term health benefits of switching to a plant-based diet, such as reduced risk of heart disease and obesity, along with potential healthcare savings associated with these benefits.

At the end, each group will present their findings to the other workshop participants, highlighting key insights and recommendations regarding a transition to a vegetarian diet

2.3. CO2 Emission Reduction through Dietary Change (20 minutes) – Individual Work

Begin with a brief introduction – By switching to a vegetarian diet, the average person can significantly reduce their meat consumption and, in turn, lower greenhouse gas emissions. In this task, we will calculate how much CO2 emissions decrease with reduced meat consumption and increased vegetable intake.

Participants will work individually with Attachment No. 4.

Participants review data on average annual meat and vegetable consumption and the associated CO2 emissions.
They calculate the CO2 emissions for a meat-based diet, assuming that an average person consumes 70 kg of meat per year. Next, they calculate CO2 emissions with reduced meat consumption, set at 10 kg per year. They determine the reduction in CO2 emissions resulting from the dietary change, while simultaneously accounting for an increase in vegetable consumption by an additional 50 kg per year.

Subsequently, participants compare their calculation results to determine how much CO2 can be saved by transitioning to a vegetarian diet.

Finally, in a group discussion, they discuss the long-term financial and ecological benefits of reducing meat consumption and how these changes might impact their daily lives.

2.4. Currency Conversion (20 minutes) – Group Work

Participants calculate the cost of a vegetarian diet from euros to Polish złoty to understand the impact of exchange rate differences on diet costs and compare these with the expenses of a meat-based diet in Poland.

Begin with a brief introduction: In the age of globalization, food purchases can be made in various currencies. Understanding exchange rates and the ability to convert costs are essential for effective household budget management, especially when adopting different diets, as costs can vary significantly by country.

Instructions: Participants receive data on the euro-to-złoty exchange rate and annual vegetarian diet costs in Germany (Attachment No. 5). They calculate the cost of a vegetarian diet in złoty by converting euros to złoty and then compare these converted costs with the annual costs of a meat-based diet in Poland.

Participants calculate the cost difference and the percentage savings resulting from switching to a vegetarian diet.Additionally, they discuss the impact of exchange rate fluctuations on diet costs, analyzing how currency changes might affect their expenses.

At the end of the task, groups present the results of their work and engage in a group discussion about the additional costs associated with a vegetarian diet (e.g., specialized products) and the potential health benefits that might outweigh higher costs if the vegetarian diet appears more expensive.

2.5. Calculating Percentage Points in Food Expenses (20 minutes) – Group Work

Participants learn how to calculate percentage point differences between expenses on a meat-based diet and a vegetarian diet.

They will be divided into small groups (3-4 people), allowing for effective collaboration and idea exchange.

Groups will review data on monthly diet costs provided in Attachment No. 6.

The groups calculate total food expenses and the percentage share of each diet (meat-based and vegetarian) within total expenses. The final task is to calculate the percentage point difference between expenses on a meat-based diet and a vegetarian diet.

Discussion:
After completing the calculations, participants discuss their results within their groups. This is followed by a larger group discussion on the significance of the calculated percentage point differences for their dietary choices. Questions for discussion include: What financial benefits can be observed from changing diets? How might these calculations impact their perception of the health and environmental value of each diet?

2.6. Price Change Simulation and Its Impact on Budget (20 minutes) – Individual Work

Participants analyze how price changes for meat and vegetables might impact their monthly food expenses and calculate potential savings from reducing meat consumption.

Participants receive data on the costs of meat and vegetables in Poland and Germany, as well as average monthly consumption figures (Attachment No. 7). Using this information, they calculate current household food expenses and then simulate expenses following a price increase (price change simulation and its impact on the household budget). Participants compare their previous expenses for both diets before and after the price increase to observe how these changes have affected their budget.

Then, assuming a decision to reduce meat consumption, participants calculate the resulting savings, expressing them in both percentages and percentage points.

After the individual work, a group discussion follows: Participants share their calculation results and insights on the impact of price changes on dietary choices. They consider how price fluctuations might influence their daily shopping decisions and discuss other factors that may be important when making dietary choices.

2.7. Nutritional Value Analysis of Diets (20 minutes) – Individual Work

Participants compare the nutritional values of a meat-based and a vegetarian diet and their impact on health, using Attachment No. 8. They review data on protein content in both diets and examine information on average monthly consumption of products from each category. Participants calculate the monthly protein intake provided by the meat-based and vegetarian diets and compare the results.

In a group discussion, they reflect on the significance of the calculated protein difference in the context of health and diet. They consider how different protein sources may affect health, identify other important nutrients, and discuss the potential benefits of a vegetarian diet.

3. Conclusion and Workshop Evaluation (10 minutes)

Goal: Enable participants to reflect on the knowledge gained and gather their feedback on the session.

Brief evaluation survey – Which information was the most useful? What would they like to explore further in the future?

Attachment No. 1 – Environmental Impact of Meat Production

• CO_2 and Other Greenhouse Gas Emissions

- Overall Emission Scale:

Meat production, particularly beef, is one of the main sources of greenhouse gas emissions. It is estimated that livestock farming accounts for approximately 14.5% of global greenhouse gas emissions. Greenhouse gas emissions are significantly higher for red meat compared to poultry or fish.

- Main Greenhouse Gases:

Carbon Dioxide (CO_2): Emitted mainly during feed production, transportation, and meat processing.

Methane (CH_4): Released by cattle during digestion (enteric fermentation); it has a much higher warming potential than CO_2 (about 25 times greater over a 100-year scale).

Nitrous Oxide (N_2O): Emitted primarily from fertilizers used in feed production.

• Water Usage

– High Water Demand:

Meat production requires vast amounts of water. Producing 1 kg of beef may require between 15,000 and 20,000 liters of water. In comparison, producing 1 kg of vegetables uses significantly less water (on average, around 1,500 liters).

– Impact on Water Resources:

Increased meat consumption leads to greater demand for freshwater and can contribute to shortages in regions with limited water resources.

- Land Degradation

– Deforestation:

Cattle farming is often associated with deforestation, especially in tropical regions like the Amazon, where forests are cleared to create pastureland.

The loss of forests affects ecosystems' ability to absorb carbon dioxide, leading to higher greenhouse gas concentrations in the atmosphere.

– Loss of Soil Fertility:

Intensive meat production contributes to land degradation, which over time leads to reduced soil productivity and issues with erosion.

- Loss of Biodiversity

– Impact on Species:

Deforestation and ecosystem degradation lead to habitat loss for many plant and animal species, threatening biodiversity.

– Ecosystem Changes:

Meat production contributes to the excessive use of pesticides and chemical fertilizers, which pollute soil and water, further impacting ecosystem health.

Discussion

Topics for Discussion:

What are the estimates for annual meat consumption in Poland, and how does it compare to the European average?
(For example, in Poland, the average annual meat consumption is around 70 kg per person, whereas in Europe it is approximately 65 kg per person.)

Do participants notice any changes in their own meat consumption?
What are their observations regarding the impact of diet on health and the environment?

What actions can they take in their households to reduce meat consumption and its environmental impact?

Attachment No. 2 – Calculating the Carbon Footprint of Meat Consumption

1. Introduction to the Topic

In 2022, the average Polish person consumed 73.2 kg of meat per year, which is over 4 kg more than the average resident of OECD countries and more than 5 kg more than the average EU resident. In Germany, according to 2020 data, meat consumption was 57.3 kg per person. In the context of climate change and environmental protection, it is essential to understand how meat consumption impacts carbon dioxide emissions.

2. CO2 Emissions Related to Meat Consumption

Average CO2 emissions from producing 1 kg of beef: 27 kg CO2e/kg

Average CO2 emissions from producing 1 kg of poultry: 6 kg CO2e/kg

Average CO2 emissions from producing 1 kg of pork: 12 kg CO2e/kg

CO2 Emissions Calculations for Different Countries

Poland:

Annual meat consumption: 73.2 kg per person.
CO2 emissions (assuming 10% is beef, 65% is pork, and 25% is poultry):

Beef:

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Pork:

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Poultry:

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Total CO_2 Emissions in Poland:

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Germany:

Annual meat consumption: 57.3 kg per person.

CO_2 emissions (assuming 40% is beef, 35% is pork, and 25% is poultry):

Beef:

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Pork:

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Poultry:

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Total CO_2 Emissions in Germany:

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3. Average CO_2 Emissions in Europe – Participants may also find data on average meat consumption in EU countries and calculate similar values to provide context for their data.

4. Calculating Changes in CO_2 Emissions with Reduced Consumption

Participants are tasked with calculating the changes in CO_2 emissions that would result from reducing meat consumption by 15% and 40%.

Example for Poland:

15% Reduction:

New consumption: 73.2 kg × 0.85 = ...

Calculating emissions for new consumption based on the percentage breakdown (assuming a 15% reduction within each category).

Example for Germany:

40% Reduction:

New consumption: ....

Calculating emissions for new consumption based on the percentage breakdown (assuming a 40% reduction within each category).

Discussion:

Participants discuss their calculation results and their significance. How can changes in meat consumption impact CO_2 emissions? What actions can they take to reduce their carbon footprint?

Attachment No. 3 – Diet Cost Analysis

In this task, participants will compare the monthly costs of a meat-based diet with a vegetarian diet and assess potential savings and the long-term financial and health effects associated with switching to a plant-based diet.

Food Cost Data:

Meat Costs:

Beef: 30 PLN/kg

Pork: 25 PLN/kg

Poultry: 15 PLN/kg

Vegetable Costs:

Fresh vegetables (e.g., carrots, potatoes, broccoli): 5 PLN/kg

Legumes (e.g., beans, lentils): 6 PLN/kg

Fruits: 7 PLN/kg

Average Monthly Consumption:

Meat-based Diet:

Beef: 2 kg

Pork: 1 kg

Poultry: 2 kg

Vegetarian Diet:

Vegetables: 15 kg

Legumes: 5 kg

Fruits: 5 kg

Monthly Cost Calculations

Cost of Meat-based Diet:
Calculate monthly meat expenses:

Beef:

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Pork:

....

Poultry:

....

Total Cost of Meat-based Diet:

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Cost of Vegetarian Diet:
Calculate monthly expenses for vegetables, legumes, and fruits:

Vegetables:

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Legumes:

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Fruits:

....

Total Cost of Vegetarian Diet:

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Calculating the Cost Difference

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Calculating Savings from Switching to a Plant-Based Diet

Monthly Savings:
If the plant-based diet costs more, consider other factors that might contribute to long-term savings, such as reduced spending on medications, improved health, and reduced healthcare costs.

Annual Savings:

Assuming the dietary change lasts for an entire year:

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Participants calculate savings over one year and five years, accounting for potential increases in food prices.

Long-Term Health Effects

Participants discuss the long-term health impacts of switching to a plant-based diet, including:

Reduced risk of heart disease, hypertension, and obesity.

Decreased healthcare costs associated with diet-related illnesses.

Finally, each group will present their findings to the other workshop participants, highlighting key insights and recommendations regarding transitioning to a vegetarian diet.

Attachment No. 4 – CO_2 Emission Reduction through Dietary Change

By switching to a vegetarian diet, the average person can significantly reduce their meat consumption, contributing to a reduction in greenhouse gas emissions. In this task, participants will calculate the decrease in CO_2 emissions resulting from reduced meat consumption and increased vegetable intake.

Data for Calculations

Average Annual Meat Consumption:

Average Polish person: 70 kg of meat per year.

Reduced Meat Consumption:

Decreased to: 40 kg of meat per year.

Increased Vegetable Consumption:

Additional 50 kg of vegetables per year.

CO_2 Emissions Associated with Production:

Average CO_2 emissions for 1 kg of meat: 27 kg CO_2e.

Average CO_2 emissions for 1 kg of vegetables: 2 kg CO_2e.

CO_2 Emission Calculations

- CO_2 Emissions from a Meat-Based Diet:

Calculate the total CO_2 emissions from 70 kg of meat:

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- CO_2 Emissions from Diet After Change:

Calculate the CO_2 emissions from 40 kg of meat:

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Calculate the CO_2 emissions from an additional 50 kg of vegetables:

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Total CO_2 Emissions with Reduced Meat Diet:

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Calculation of CO_2 Emission Reduction

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Summary of Calculations

CO_2 Emissions with Meat-Based Diet: .... kg CO_2e

CO_2 Emissions with Reduced Meat Diet: .... kg CO_2e

CO_2 Emission Reduction: .... kg CO_2e

After completing the calculations, participants will discuss the following:

Long-term Financial Benefits – How switching to a vegetarian diet may affect food expenses and health-related costs.

Environmental Benefits – How reducing meat consumption can contribute to environmental protection and lower CO_2 emissions.

Practical Aspects of Dietary Change – What challenges and benefits participants might encounter when transitioning to a plant-based diet.

Attachment No. 5 – Currency Conversion and Diet Cost Analysis

In the era of globalization, food purchases can be made in various currencies. Understanding exchange rates and the ability to convert costs are essential for effective household budget management, especially when adopting different diets that may vary in cost depending on the country.

Data for Conversions

Euro to Polish Zloty Exchange Rate:
1 euro = 4.3 PLN

Annual Costs of a Vegetarian Diet in Germany:
Cost of vegetarian diet: 750 euros per year.

Annual Costs of a Meat-Based Diet in Poland:
Cost of meat-based diet: 4800 PLN per year.

Diet Cost Calculations for a Vegetarian Diet

– Conversion of vegetarian diet cost from euros to Polish zloty:

Cost of diet in PLN = Cost of diet in euros × Euro exchange rate

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Comparison with Meat-Based Diet Costs:

Cost of Meat-Based Diet in Poland: 4800 PLN per year.

Cost Difference:
Participants calculate the difference between the costs of both diets:

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Percentage Savings:

Participants calculate the percentage savings (relative to the meat-based diet) as follows:

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Analysis of the Impact of Currency Exchange Rate Changes

Participants discuss how currency exchange rate fluctuations can affect diet costs:

– If the euro exchange rate rises to 5.0 PLN, the calculations for the vegetarian diet cost will change, impacting the total diet cost in PLN.

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– Participants can perform calculations for different exchange rate scenarios (e.g., 4.8 PLN, 5.2 PLN) and assess how these changes might influence their dietary choices.

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After the calculations, groups discuss:

- Additional Costs Associated with a Vegetarian Diet

- What specialized products might be more expensive (e.g., meat substitutes, organic products)?

- Health Benefits of a Vegetarian Diet – What long-term health benefits could offset higher costs, such as reduced risk of heart disease, obesity, or type 2 diabetes?

Each group then presents their calculation results and conclusions on diet cost conversion and the impact of currency exchange rates on expenses. The discussion can also include participants' personal experiences with a vegetarian diet and their observations on product prices and availability.

Attachment No. 6 – Calculating Percentage Points in Food Expenses

In this task, participants will learn how to calculate percentage point differences between spending on animal-based products and plant-based products. Understanding these differences will help participants assess the financial benefits of switching to a plant-based diet, as well as its implications for health and the environment.

Monthly Product Cost Data by Category

Monthly Costs for Animal-Based Products:

Beef: 30 PLN/kg, average monthly consumption: 1.5 kg

Pork: 25 PLN/kg, average monthly consumption: 3.5 kg

Poultry: 15 PLN/kg, average monthly consumption: 2 kg

- Plant-Based Products:

Vegetables: 5 PLN/kg, average monthly consumption: 15 kg

Legumes: 6 PLN/kg, average monthly consumption: 5 kg

Fruits: 7 PLN/kg, average monthly consumption: 5 kg

Total Cost of Animal-Based Products Purchase:

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Total Cost of Plant-Based Products Purchase:

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Total Cost of the Entire Diet:

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Calculation of Percentage Share of Expenses:

– Percentage of expenses on animal-based products:

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– Percentage of expenses on plant-based products:

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Calculation of Percentage Point Difference:

Participants calculate the percentage point difference between expenses on animal-based products and plant-based products:

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After completing the calculations, participants discuss the results in groups and then in a larger forum:

- How do differences in percentage expenses influence the dietary choices of workshop participants?

- What financial benefits can be observed when switching from a meat-based to a vegetarian diet?

- How do these calculations affect their perception of the health and environmental values of both diets?

Poland has approximately 38 million residents, and Germany has around 83 million. Through their calculations, participants may recognize how significant their dietary choices are in both local and global contexts. Dietary choices not only impact individual expenses but also have broader implications for public health and environmental well-being.

Attachment No. 7 – Price Change Simulation and Its Impact on Budget

Food Cost Data

Food Costs in Poland:

Beef: 30 PLN/kg, average monthly consumption is 1.5 kg per person

Pork: 25 PLN/kg, average monthly consumption is 2.5 kg per person

Poultry: 15 PLN/kg, average monthly consumption is 2 kg per person

Total Cost of Animal-Based Products per Person in Poland:

…………………………………………………………………

Vegetables: 5 PLN/kg, average monthly consumption is 15 kg per person

Legumes: 6 PLN/kg, average monthly consumption is 5 kg per person

Fruits: 7 PLN/kg, average monthly consumption is 5 kg per person.

Total Cost of Plant-Based Products per Person in Poland:

…………………………………………………………………

Food Costs in Germany:

Beef: 9 euros/kg, average monthly consumption is 2 kg per person

Pork: 7 euros/kg, average monthly consumption is 1.5 kg per person

Poultry: 5 euros/kg, average monthly consumption is 2 kg per person

Total Cost of Animal-Based Products per Person in Germany:

…………………………………………………………………

Vegetables: 2 euros/kg, average monthly consumption is 15 kg per person

Legumes: 3 euros/kg, average monthly consumption is 5 kg per person

Fruits: 4 euros/kg, average monthly consumption is 5 kg per person

Total Cost of Plant-Based Products per Person in Germany:

....

Calculating Current Food Expenses for a Four-Person Household:

For Poland, the total food expenses for a four-person family are:

....

....

In Germany, the total food expenses for a four-person family are:

....

....

Price Increase Simulation

Example New Prices (10% Price Increase):

In Poland:

Beef increases to 33 PLN/kg

Pork increases to 27.5 PLN/kg

Poultry increases to 16.5 PLN/kg

Calculating New Expenses

Expenses After Price Increase in Poland:

....

....

....

Expenses After Price Increase in Germany:

....

....

....

Calculating Savings with Meat Reduction

Participants assume they decide to reduce meat consumption by 30%.

....

....

Calculating New Costs After Reduction:

....

....

After completing the calculations, participants share their conclusions:

- How do price changes affect participants' daily shopping decisions?

- What savings can be observed with reduced meat consumption?

- What other factors are important when making dietary choices, such as health benefits or product availability?

Attachment No. 8 – Nutritional Value Analysis of Diets

Nutritional Data

A. Protein Content in Meat-Based Diet:

Beef: 26 g protein per 100 g

Pork: 25 g protein per 100 g

Poultry: 30 g protein per 100 g

B. Protein Content in Vegetarian Diet:

Vegetables: 2 g protein per 100 g (average for various vegetables)

Legumes (e.g., beans, lentils): 9 g protein per 100 g

Fruits: 1 g protein per 100 g (average for various fruits)

Average Monthly Consumption of Products

A. Meat-Based Diet:

Beef: 2 kg per month

Pork: 1 kg per month

Poultry: 2 kg per month

B. Vegetarian Diet:

Vegetables: 15 kg per month

Legumes: 5 kg per month

Fruits: 5 kg per month

Calculations

A. Protein Calculations in Meat-Based Diet:

Beef:

Monthly consumption: 2 kg = 2000 g

Protein content:

Protein from Beef: = ...

Pork:

Monthly consumption: 1 kg = 1000 g

Protein content:

Protein from Pork: = ...

Poultry:

Monthly consumption: 2 kg = 2000 g

Protein content:

Protein from Poultry:= ……………………………………

Total Protein from Meat-Based Diet:

……………………………………………………………

Vegetables:

Monthly consumption: 15 kg = 15,000 g

Protein content:

Protein from Vegetables = ………………………

Legumes:

Monthly consumption: 5 kg = 5000 g

Protein content: 5000 g × 9 g protein per 100 g = 450 g of protein

Protein from Legumes = ……………………………………

Fruits:

Monthly consumption: 5 kg = 5000 g

Protein content:

Protein from Fruits = ……………………………………

Total Protein from Vegetarian Diet:

……………………………………………………………

Comparison of Protein Content

Protein in the meat-based diet:

Protein in the vegetarian diet:

6. Discussion

After completing the calculations, participants discuss the differences in protein content and their significance:

- How might the calculated differences in protein affect health? What other nutrients might be important in a vegetarian diet?

- How can different sources of protein impact health? What benefits might come from a vegetarian diet?

Scenario No. 6

"Can you live without plastic?"

Workshop Goal:

- Raising Awareness about the environmental impact of plastic, including presenting data on average plastic consumption by individuals in Poland, Germany, and Europe.
- Strengthening Mathematical Skills, such as calculating surface area, volume, and unit conversions, in the context of plastic consumption.
- Improving Arithmetic Accuracy.
- Developing Practical Skills related to living a "plastic-free" lifestyle.

Duration: 3 hours

Required Materials:

- Dry-erase boards and markers for recording group task results and calculations.
- Calculators for each participant to perform calculations related to percentages.
- Attachment No. 1: Statistics on packaging waste.
- Attachment No. 2: The negative impact of plastic on the environment.
- Attachment No. 3: Calculating the amount of space occupied by plastic waste (bottles).
- Attachment No. 4: Plastic bottle usage by a 4-person family over 10, 20, and 30 years.
- Attachment No. 5: Filling a truck with plastic waste from a 5-person family.
- Attachment No. 6: Usage of plastic bags by a family.
- Attachment No. 7: Plastic consumption and trash bin capacity.
- Attachment No. 8: Calculating the volume of ice cream boxes and analyzing plastic consumption.
- Attachment No. 9: Kahoot quiz on the amount of plastic waste and its environmental impact.

Workshop Plan:

1. Introduction to the Workshop Topic (20 minutes)

Presentation:
According to data from the European Parliament website, in 2021, each person living in the EU generated an average of 36.1 kg of plastic packaging waste. The amount of plastic packaging waste generated per person increased by approximately 29% (or 8.1 kg per person) between 2010 and 2021.
The total amount of plastic waste generated in the EU in 2021 was 16.13 million tons. Approximately 6.56 million tons of plastic waste were recycled.

Present statistics on packaging waste, especially plastic packaging, using Attachment No. 1.

Discuss the issue of plastic consumption and its negative impact on the environment, including consequences for ecosystems, water pollution, and threats to fauna and flora, using Attachment No. 2.

After reviewing the data, participants will engage in a group discussion:

- What changes in daily habits can reduce plastic consumption?

- What alternatives to plastic can be used in everyday life?

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Calculating the Space Occupied by Plastic Waste (Bottles) – Individual Work (20 minutes)

On average, one person in Poland uses 220 plastic bottles annually. Assuming that 110 bottles have a capacity of 0.5 liters and 110 bottles have a capacity of 1 liter, participants will calculate the total volume of bottles used by one class of children in a school (assuming there are 30 students in the class) using Attachment No. 3.

Next, they will calculate the volume of a standard rectangular classroom with dimensions of 6 m by 7 m by 3.5 m in height.

Finally, participants will calculate what percentage of the classroom's space is occupied by the bottles used by 30 students over one year, 5 years, and 10 years.

The goal of the task is to make workshop participants aware of how much plastic waste they generate over several years.

2.2. Plastic Bottle Consumption by a 4-Person Family Over 10, 20, and 30 Years – Group Work (20 minutes)

On average, one person in Poland uses 220 plastic bottles annually. Assume that 110 bottles have a capacity of 0.5 liters and 110 bottles have a capacity of 1 liter.

Participants, working in groups, will calculate how many bottles a 4-person family uses in a year and then calculate the total volume of these bottles over 30 years.

Finally, they will compare the calculated volume to the volume of an Olympic swimming pool, working with Attachment No. 4.

Question: How much plastic is used by a neighborhood consisting of 45 four-person families?

2.3. Filling a Truck with Plastic Waste by a 5-Person Family – Individual Work (20 minutes)

On average, one person in Poland generates 40 kg of plastic waste annually.

In this task, participants will calculate how long it would take for a 5-person family to fill a 26-ton truck with plastic waste – working with Attachment No. 5. Then, they will calculate the volume of a standard truck trailer and compare it to the volume of plastic waste produced by the family over the given period.

2.4. Plastic Bag Consumption by a Family – Individual Work (20 minutes)

On average, one person in Poland uses approximately 200 single-use plastic bags annually.

In this task, participants will independently calculate how many bags a 4-person family uses in one year, the total volume occupied by these bags, and then compare the results with the volume of a standard trash container – working with Attachment No. 6.

After the calculations, a group discussion will be held regarding possible ways to reduce plastic bag consumption.

2.5. Plastic Consumption and Trash Bin Capacity – Group Work (20 minutes)

On average, one person in Poland produces 35 kg of plastic waste per year. In this task, workshop participants will calculate how much plastic a 5-person family produces in one year and how many such families are in a city with a population of 200,000 residents (referencing Gdynia).

They will then calculate how many trash bins will be needed to store the plastic waste, assuming each bin has a capacity of 1.5 m^3 – working with Attachment No. 7.

2.6. Comparing the Volume of Ice Cream Boxes – Group Work (30 minutes)

In this task, participants will calculate the volumes of different ice cream boxes and compare them with each other – working with Attachment No. 8. By doing so, they will learn how the volume of these boxes translates into the amount of plastic waste generated by different types of packaging. The goal is to understand how small changes in packaging volume can affect plastic consumption.

Additionally, the task for the groups is to come up with at least 5 ideas for reusing plastic ice cream boxes, which they will present in the forum.

2.7. Kahoot Quiz on the Amount of Plastic Waste We Generate (10 minutes)

At the end of the workshop section, participants will take a quiz with 10 questions about the amount of plastic waste we produce and its impact on the environment – Attachment No. 9.

3. Conclusion and Workshop Evaluation (10 minutes)

Goal: To allow participants to reflect on the knowledge they have gained and collect their feedback on the workshop.

A brief evaluation survey – asking what information was most useful and what they would like to explore further in the future.

Attachment No. 1 – Statistics on Packaging Waste

What are packaging materials?

Packaging refers to products used for storing, protecting, transporting, delivering, or presenting goods.

How much packaging waste do we generate?

Packaging has an impact on the environment. In 2021, each resident of the EU generated an average of 189 kilograms of packaging waste. This is more than 20% higher than ten years ago.

In 2021, the amount of packaging waste per person was 189 kg – 34 kg more than 10 years ago.

According to data from the European Parliament, different countries produce varying amounts of waste, ranging from just 74 kg per person in Croatia to 246 kg per person in Ireland. The most recent data for Poland is from 2019, when it was 172 kg per person.

In 2021, the EU produced a total of 84.3 million tons of packaging waste – 4.8 million tons more than the previous year. The majority consisted of paper and cardboard (40.3%), followed by plastics (19%), glass (18.5%), wood (17.1%), and metal (4.9%).

In 2021, each person in the EU generated an average of 36.1 kg of plastic packaging waste. The amount of plastic packaging waste produced per person increased by about 29% (or 8.1 kg per person) from 2010 to 2021.

The total amount of plastic waste generated in the EU in 2021 was 16.13 million tons. Approximately 6.56 million tons of plastic waste was recycled.

Processing of Plastic Waste in Europe

In Europe, the most commonly used method for disposing of plastic waste is energy recovery, which involves converting plastic waste into heat, electricity, or fuel through incineration or other processes. Recycling is the second most common method of processing plastic waste.

Half of the plastics collected for recycling are exported to non-EU countries. The reasons for this export include a lack of capacity, technology, or financial resources needed to process the waste domestically. In 2021, the export of all types of waste from the EU to non-EU countries amounted to 33 million tons. The majority of these waste materials consist of ferrous and non-ferrous metal scrap, paper, plastic, textiles, and glass. They are mainly sent to Turkey, India, and Egypt.

The relatively low level of plastic recycling in the EU results in significant losses for the economy and the environment. It is estimated that the value of plastic packaging is lost by 95% after a short period of initial use.

Approximately 22 million tons of plastic entered soils, rivers, and oceans in 2019, and it is predicted that the amount of plastic entering the environment will double by 2060.

In 2019, plastics generated 1.8 billion tons of greenhouse gases (GHG), accounting for 3.4% of global emissions. 90% of these emissions came from the production and processing of plastics derived from fossil fuels. By 2060, emissions from the entire life cycle of plastics are expected to more than double, reaching 4.3 billion tons of greenhouse gas emissions.

Attachment No. 2 – The Negative Impact of Plastic on the Environment

Plastic consumption has become one of the most serious environmental problems of the modern world. Every year, hundreds of millions of tons of plastic are produced worldwide, and a significant portion ends up as waste, posing a threat to the natural environment. Plastic not only litters our surroundings but also causes serious consequences for ecosystems, as well as the health of humans and animals.

1. Water Pollution

- Plastic waste that enters the waters of rivers, lakes, and oceans breaks down into microscopic fragments known as microplastics. These particles are difficult to remove and can be ingested by aquatic organisms.

– Water pollution by plastic leads to disruptions in the food chain because marine organisms mistake plastic for food, causing plastic to enter the food chain. This impacts the health of animals and humans who consume these organisms.

2. Threat to Fauna and Flora

Plastic waste, such as fishing nets, bags, and bottles, poses a serious threat to wildlife. Animals like sea turtles, seabirds, and mammals often become entangled in waste or mistake it for food, leading to death.

Seabirds that ingest plastic can suffer serious health problems, including blockages in their digestive systems, which leads to starvation and death. Studies have shown that more than 90% of seabirds have plastic fragments in their bodies.

3. Degradation of Terrestrial Ecosystems

- Plastic that ends up in landfills does not biodegrade for hundreds of years. Instead, it breaks down into microplastics, which can seep into the soil and affect the quality of groundwater.

- As plastic litters various habitats, it leads to habitat loss and a decrease in biodiversity. Plant and animal species may go extinct as a result of changes to their natural environments.

4. Impact on Human Health

- Microplastic particles have been found in food, including sea salts and fish, raising concerns about their impact on human health. There is a risk that these harmful chemicals may cause health problems, including cancer.

- Some types of plastic contain harmful chemicals that can leach into food and beverages, potentially leading to hormonal imbalances and other health issues.

5. Economic Consequences

- Plastic pollution also has economic consequences. The costs associated with cleaning up beaches, rivers, and other ecosystems can be substantial, putting a strain on local community budgets.

- Environmental pollution can impact tourism, which in turn affects local economies that rely on tourism related to natural attractions.

Attachment No. 3 – Calculating the Amount of Space Occupied by Plastic Waste (Bottles)

Step 1: Calculating the number of plastic bottles used by the class.

Number of bottles used by one person per year:

On average, one person in Poland uses 220 bottles annually.

Bottle distribution:

- 110 bottles with a capacity of 0.5 liters.

- 110 bottles with a capacity of 1 liter.

Calculating the number of bottles used by the class:
Assume there are 30 students in the class.

Calculations:

....

Step 2: Calculating the total capacity of used bottles
Calculating the capacity of bottles used by one person per year:
Capacity of 0.5-liter bottles:

....

Capacity of 1-liter bottles:

....

Total capacity of the bottles:

....

Calculating the annual capacity of bottles used by a class of 30 students:

....

....

Step 3: Calculating the volume of the classroom

Classroom dimensions:

Length: 6 m

Width: 7 m

Height: 3.5 m

Calculating the volume of the classroom:

…………………………………………………………………

…………………………………………………………………

Converting the volume of the classroom to liters (1 m^3 = 1000 l):

…………………………………………………………………

…………………………………………………………………

Step 4: Calculating the percentage of the classroom volume occupied by bottles from the class's annual usage:

Calculating the percentage of the occupied volume:

…………………………………………………………………

Step 5: Calculations for 5 and 10 years

Calculating the volume of bottles used by the class over 5 years:

…………………………………………………………………

Calculating the percentage of the classroom volume occupied by bottles over 5 years:

…………………………………………………………………

Calculating the volume of bottles used by the class over 10 years:

…………………………………………………………………

Calculating the percentage of the classroom volume occupied by bottles over 10 years:

…………………………………………………………………

As a summary, participants discuss the obtained values in the context of the plastic problem generated every day.

Attachment No. 4 – Plastic Bottle Consumption by a 4-Person Family Over 10, 20, and 30 Years

Step 1: Calculating the annual plastic bottle consumption for a 4-person family

Plastic bottle consumption per person per year:

On average, one person in Poland uses 220 bottles annually.

Calculating the number of bottles used by a 4-person family:

………………………………………………………………………

Step 2: Calculating the total volume of bottles used over 10, 20, and 30 years

Bottle distribution:

110 bottles with a capacity of 0.5 liters.

110 bottles with a capacity of 1 liter.

Calculating the capacity of bottles used by one person in a year:

Capacity of 0.5-liter bottles:

………………………………………………………………………

Capacity of 1-liter bottles:

………………………………………………………………………

Total capacity of the bottles:

………………………………………………………………………

Calculating the annual capacity of bottles used by a 4-person family:

………………………………………………………………………

………………………………………………………………………

Calculating the consumption by the family over 10, 20, and 30 years:

………………………………………………………………………

………………………………………………………………………

………………………………………………………………………

Step 3: Calculating plastic consumption by a neighborhood consisting of 45 families

Calculating the annual bottle consumption by the neighborhood:

....

....

Calculating the total volume of bottles used by the neighborhood over 30 years:

....

....

Step 4: Comparing with the volume of an Olympic swimming pool

Volume of an Olympic swimming pool:

A standard Olympic pool has dimensions of 50 meters in length, 25 meters in width, and 2 meters in depth.

Calculating the volume of the pool:

....

....

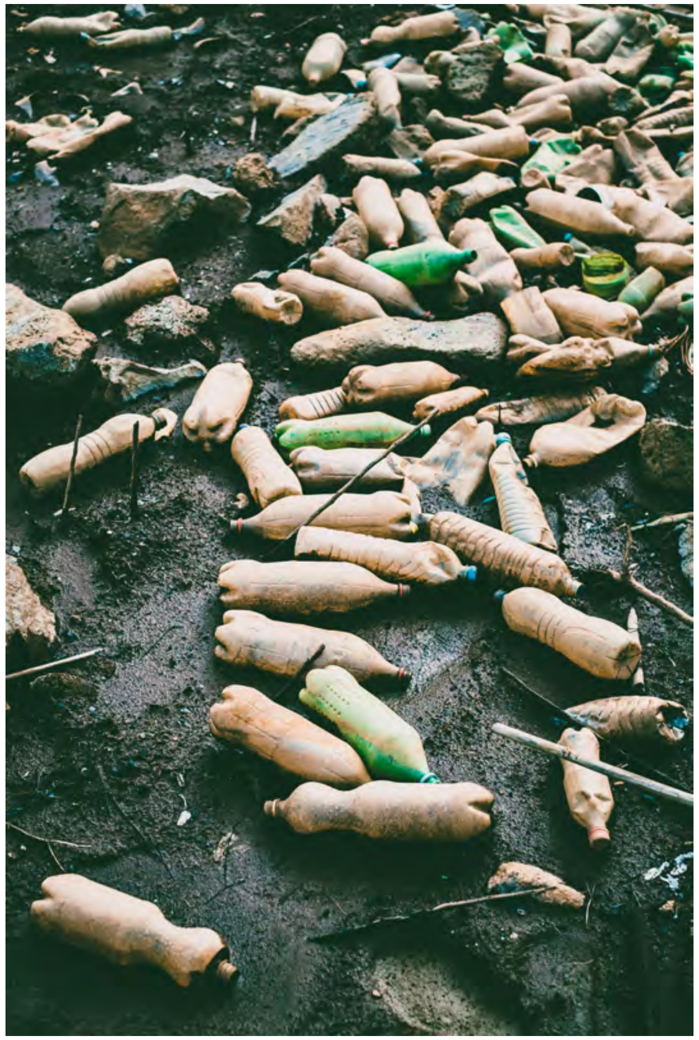
Converting to liters (1 m^3 = 1000 l):

....

Comparing the volumes:

The percentage of the pool's volume occupied by the bottles used by the neighborhood over 30 years:

....



Attachment No. 5 – Filling a Truck with Plastic Waste by a 5-Person Family

Step 1: Calculating the annual plastic waste production by the family
Plastic waste production per person per year:

On average, one person in Poland generates 40 kg of plastic waste annually.

Calculating the waste production by a 5-person family per year:

……………………………………………………………

Step 2: Calculating how long it will take to fill a truck

Truck capacity:

The capacity of a standard truck trailer is 26 tons, which is equivalent to ……………… kg.

Calculating the time needed to fill a truck with plastic waste produced by a 5-person family:

……………………………………………………………

……………………………………………………………

Step 3: Calculating the volume of the truck trailer
Dimensions of a standard truck trailer:

Length: 13.6 m

Width: 2.5 m

Height: 2.6 m

Calculating the volume of the truck trailer:

……………………………………………………………

……………………………………………………………

Step 4: Calculating the volume of plastic waste produced by the family

Assuming that 1 kg of plastic occupies approximately 2.5 liters of volume.

´

Calculating the volume of waste produced by the family annually:

………………………………………………………………

………………………………………………………………

Step 5: Comparing the volume of the truck trailer with the volume of plastic waste

Comparison of the volume of the truck trailer with the volume of waste:

Volume of the trailer: ……………… [liters]

Volume of waste for 1 year: ……………… [liters]

Volume of waste for 5 years: ……………… [liters]

Volume of waste for 10 years: ……………… [liters]

Calculating the percentage of the trailer volume occupied by waste over 10 years:

………………………………………………………………

………………………………………………………………

Attachment No. 6 – Plastic Bag Consumption by a Family

Step 1: Calculating the annual plastic bag consumption by a 4-person family
Plastic bag consumption per person per year:

On average, one person in Poland uses 200 plastic bags annually.

Calculating the number of bags used by a 4-person family:

....

Step 2: Calculating the volume of used bags
Assume that the volume of one plastic bag, when rolled into a ball, is approximately 0.4 liters.

Calculating the total volume of bags used by the family in one year:

....

Converting the volume to cubic meters (1 m³ = 1000 l):

....

Step 3: Calculating the volume of a standard trash container
Dimensions of a standard trash container:

Length: 1.2 m

Width: 0.8 m

Height: 1.1 m

Calculating the volume of the container:

....

....

Step 4: Comparing the volume of used bags with the volume of the container
Calculating the percentage of the container's volume occupied by the bags:

....

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Attachment No. 7 – Plastic Consumption and Trash Bin Capacity

Step 1: Calculating the annual plastic production by a 5-person family
Plastic waste production per person per year:

On average, one person in Poland generates 35 kg of plastic waste annually.

Calculating the plastic production by a 5-person family:

……………………………………………………………

……………………………………………………………

Step 2: Calculating the number of families in the city

Assumption:

The population of the city (e.g., Gdynia) is 200,000 residents.

Calculating the number of families in the city:

Assume that the average number of people in a family is 5.

……………………………………………………………

……………………………………………………………

In the city, there are ………….. families, so the plastic production by these families needs to be calculated.

Step 3: Calculating the total plastic production in the city
Calculating the total plastic production by all families in the city:

……………………………………………………………

……………………………………………………………

The total plastic production in the city is ………….. kilograms per year.

Step 4: Calculating the volume of plastic waste

Assumption:

The average density of plastic waste is 0.1 kg/l (plastics are quite light and do not occupy large volumes when converted to kilograms).

Calculating the volume of plastic in liters:

....

....

The total volume of plastic produced by all families in the city is .... million liters.

Converting the volume to cubic meters ($1\ m^3 = 1000\ l$):

....

....

The total volume of plastic waste in the city is .... m^3.

Step 5: Calculating the number of trash bins needed

Assumption:

The capacity of one trash bin is $1.5\ m^3$.

Calculating the number of trash bins needed to store plastic waste:

....

....

In total, approximately .... trash bins are needed to store all the plastic waste produced by the residents of the city over the course of a year.

Step 6: Group Discussion

After completing the calculations, participants can engage in a discussion about ways to reduce plastic consumption. Topics to consider:

- What alternatives to plastic waste are available?
Reusable bags, paper or glass packaging, eco-friendly containers.

- What changes in shopping habits can help reduce plastic consumption?
Carrying personal shopping containers instead of plastic bags, avoiding products with excessive plastic packaging.

- What are the environmental benefits of reducing plastic waste usage?

Reduction of environmental pollution, less burden on recycling systems.

Attachment No. 8 – Calculating the Volume of Ice Cream Boxes and Analyzing Plastic Consumption

Step 1: Calculating the volume of 3 ice cream boxes in the shape of a rectangular prism

Box 1:

Dimensions of the box:

Length = 12 cm

Width = 8 cm

Height = 10 cm

Formula for the volume of a rectangular prism:
Volume = length × width × height

....

....

The volume of Box 1 is ....

Box 2:

Dimensions of the box:

Length = 14 cm

Width = 10 cm

Height = 8 cm

....

....

The volume of Box 2 is ....

Box 3:

Dimensions of the box:

Length = 10 cm

Width = 10 cm

Height = 12 cm

....

....

The volume of Box 3 is ....

Step 2: Calculating plastic consumption based on the volume of the boxes

Assumption:

For every 100 cm³ of packaging volume, approximately 0.0005 kg of plastic is used. This means that the larger the packaging, the more plastic is consumed in its production.

Calculating the amount of plastic used in the production of the boxes:

Box 1:

....

....

Box 2:

....

....

Box 3:

....

....

Step 3: Comparing plastic consumption
Participants should notice that with larger boxes, plastic consumption increases proportionally to the volume.
Example:

Box 1 uses .... kg of plastic.

Box 2 uses .... kg of plastic.

Box 3 uses .... kg of plastic.

Step 4: Discussion on the environmental impact
After the calculations, participants can move on to a discussion about the impact of plastic on the environment.
Topics to consider:

How does a small change in the volume of packaging affect plastic consumption?

Can reducing the volume of packaging help decrease plastic consumption?

What changes in consumer habits can contribute to reducing plastic consumption?

Attachment No. 9 – Kahoot Quiz on the Amount of Plastic Waste and Its Environmental Impact

Question 1: How much plastic waste does the average person in Poland produce annually?

A) 10 kg
B) 35 kg
C) 50 kg
D) 100 kg

Correct answer: B) 35 kg

Question 2: How many plastic bags are used globally each year?

A) 10 billion
B) 100 billion
C) 500 billion
D) 1 trillion

Correct answer: C) 500 billion

Question 3: What percentage of plastic bottles is recycled worldwide?

A) 5%
B) 9%
C) 25%
D) 50%

Correct answer: B) 9%

Question 4: In which year did the European Union generate an average of 36.1 kg of plastic waste per capita?

A) 2010
B) 2015
C) 2021
D) 2023

Correct answer: C) 2021

Question 5: How long can plastic take to decompose in the environment?

A) 10-20 years
B) 50-100 years
C) 100-1000 years
D) Up to 1000 years or longer
Correct answer: D) Up to 1000 years or longer

Correct answer: D) Up to 1000 years or longer

Question 6: What percentage of plastic produced worldwide is single-use plastic?

A) 10%
B) 25%
C) 50%
D) 79%

Correct answer: C) 50%

Question 7: What is the main reason for plastic pollution in the oceans?

A) The automotive industry
B) Too much waste in landfills
C) Plastic waste collected in the oceans
D) Plastic bags and single-use packaging

Correct answer: D) Plastic bags and single-use packaging

Question 8: What percentage of plastic waste ends up in the oceans?

A) 5%
B) 10%

Question 8: What percentage of plastic waste ends up in the oceans?

A) 5%
B) 10%
C) 25%
D) 40%

Correct answer: B) 10%

Question 9: What can help reduce plastic waste?

A) Increasing plastic production
B) Recycling plastic
C) Only using plastic packaging
D) Reducing the number of stores

Correct answer: B) Recycling plastic

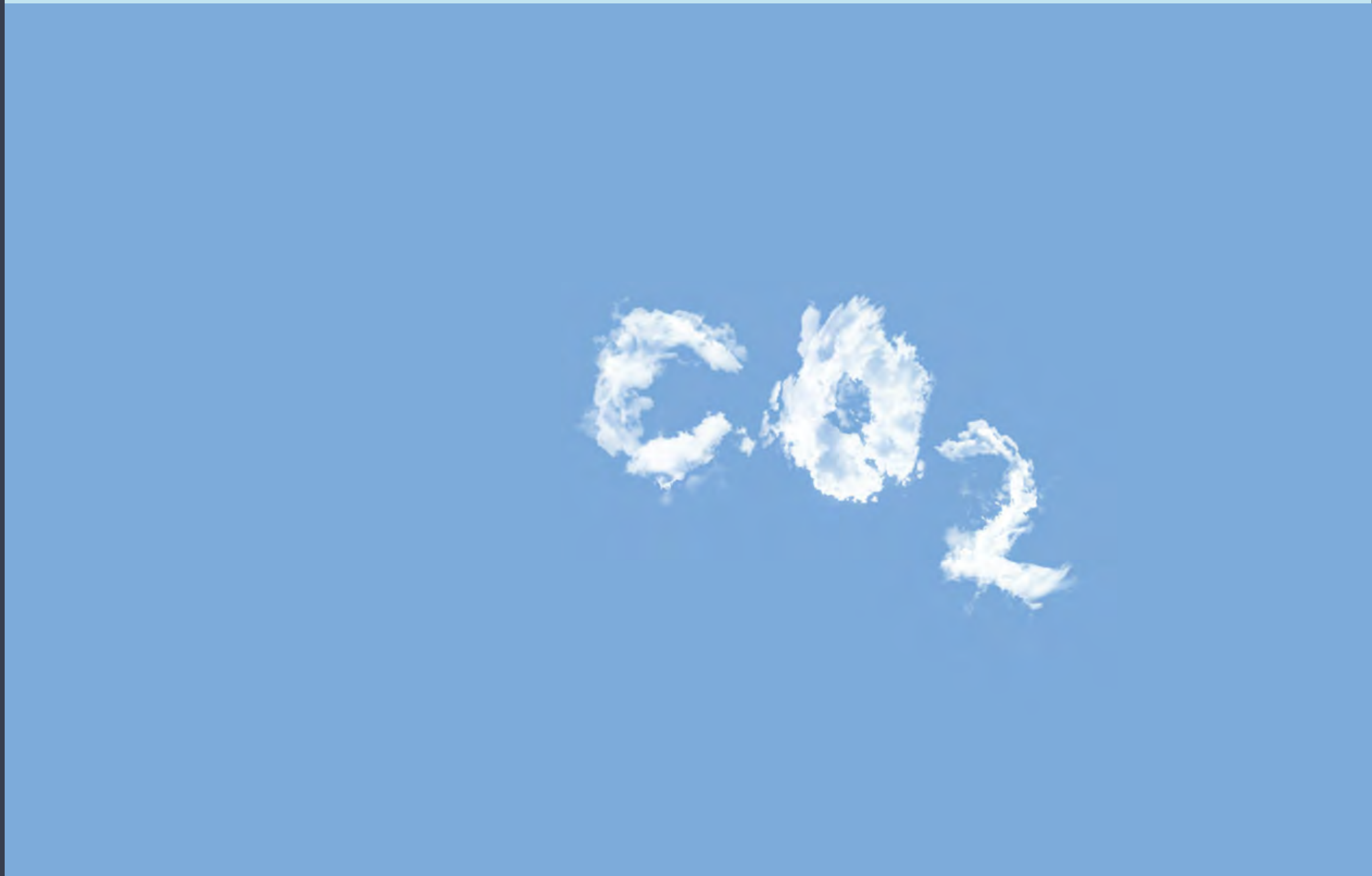
Question 10: Which animals are particularly endangered by plastic waste in the oceans?

A) Birds
B) Turtles
C) Fish
D) All of the above

Correct answer: D) All of the above

Scenario No. 7

". Do you know how much clean air weighs?"



Objective of the Workshop:

- Participants will refine their calculation skills related to determining the volumes of rectangular prisms, cylinders, cones, and other spatial shapes, as well as calculating the mass of air based on its volume and density. They will be required to apply various mathematical formulas that are essential in the sciences, such as the volume of a cube, cylinder, and cone, along with mass calculations involving the density of materials (e.g., air).

- During the sessions, participants will reinforce their understanding of converting between volume units, transitioning between cubic meters, liters, and milliliters, which is essential for converting results across different units of measurement and adapting them for practical applications.

- The sessions will focus on practical calculation exercises that enhance the ability to perform quick and accurate calculations in the context of volume and mass determination. Participants will need to demonstrate proficiency in performing calculations both manually and with the aid of calculators, as well as correctly applying mathematical principles to real-world problems.

- The goal of the sessions is not only to teach mathematics but also to foster an understanding of how calculations related to volume, mass, and air density can connect to real-world ecological challenges, such as air pollution. Participants will learn how calculating the mass of air in rooms and buildings can relate to air quality, pollution, and environmental improvement.

- The sessions demonstrate how the application of mathematics and physics in everyday life can deepen our understanding of ecological processes. Examples like calculating the mass of air in various spaces will help participants grasp how atmospheric conditions change and why it is crucial to monitor air quality.

- An additional aim is to educate participants about the link between air science and environmental protection. Learning to calculate air volume, mass, and density will raise awareness of how small changes in air volume (e.g., due to pollution) can impact daily life, human health, vegetation, and the planet as a whole.

Duration: 3 hours

Required materials:

- Whiteboards and dry-erase markers for recording group task results and calculations
- Calculators for each participant to perform calculations related to percentages
- Attachment No. 1: Composition of air
- Attachment No. 2: Information on regions in Poland and Germany with the highest and lowest air pollution levels
- Attachment No. 3
- Attachment No. 4
- Attachment No. 5
- Attachment No. 6
- Attachment No. 7
- Attachment No. 8
- Attachment No. 9
- Attachment No. 10
-

Workshop Plan:

1. Introduction to the Workshop Theme (20 minutes)

Discussion on the Composition of Air:

The facilitator begins a discussion on the composition of air. Participants have the opportunity to share what they know about air, its components, and its properties.

Discussion Questions:

- Which gases dominate in the air?

- What is clean air?

- What is the importance of clean air for human health?

Attachment No. 1: Composition of Air – a review of air composition, its dominant components (nitrogen 78%, oxygen 21%, and other gases in small amounts), and the impact of pollutants on air quality.

The facilitator provides an example of how clean air affects health and the environment.

Discussion on Air Pollution

Discussion Questions:

- Which regions of Poland and Germany have the most polluted air?
- What are the most common sources of air pollution?
- What actions can help improve air quality?

Attachment No. 2: Information on regions in Poland and Germany with the highest and lowest air pollution levels. The facilitator highlights current challenges related to pollution (e.g., smog, industrial emissions).

Ideas for Reducing Pollution:

Participants collaboratively propose solutions, such as:

- Reducing exhaust emissions through changes in transportation.
- Increasing the use of renewable energy sources.
- Reducing fossil fuel consumption and industrial pollution.

Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Calculating the Mass of Air in a Room with Known Dimensions – Group Work (20 minutes)

Participants work in small groups. The aim of the exercise is to familiarize them with the concept of mass. Each group is tasked with calculating the mass of air in a room, given its dimensions and the density of air. Additionally, the exercise provides practical training in unit conversion and improves calculation skills.

The facilitator begins with a presentation of the basic definitions needed for the exercise—volume, mass, and density (Attachment No. 3).

Then, they write the formula for calculating the mass of air on the board:

$$\text{Mass} = \text{Volume} \times \text{Density}$$

Using a simple example, the facilitator demonstrates how to calculate mass when the density of a substance and its volume are known (e.g., the mass of air in a balloon).

Next, participants work in groups to calculate the volume of air in a room with given dimensions and subsequently determine its mass—using Attachment No. 4.
The exercise concludes with a group discussion on how air quality affects human health and the environment.

2.2. Calculating the Mass of Air in 70 Balloons – Individual Work (20 minutes)

Assuming each balloon has a volume of 10 liters (0.01 m^3), participants are tasked with calculating the mass of air in 70 balloons prepared for a senior's birthday party. Participants work independently with Attachment No. 5. The goal of this exercise is to reinforce the relationship between mass, volume, and density while improving calculation skills.

2.3. Introduction to the Algorithm for Calculating the Polish Air Quality Index – Group Work (30 minutes)

The Polish Air Quality Index (AQI) is an indicator used to assess air quality in Poland, taking into account the concentration of various air pollutants, such as particulate matter (PM10, PM2.5), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and sulfur dioxide (SO_2).

The index is calculated based on the concentrations of these substances in a specific location and time, with the result depending on the dominant pollutant in the air.

The algorithm for calculating the Polish Air Quality Index includes the following steps:

Measurement of Pollutant Concentrations
Measurement of concentrations of pollutants such as:

- PM10 (particulate matter with a particle diameter up to 10 μm)

- PM2.5 (particulate matter with a particle diameter up to 2.5 μm)

- NO_2 (nitrogen dioxide)

- CO (carbon monoxide)

- O_3 (ozone)

- SO_2 (sulfur dioxide)

These data are obtained from air quality monitoring within the specific region.

2. Determining Index Values for Each Pollutant

For each air pollutant, a separate index is calculated based on its concentration. Tables with threshold values are used to determine which concentration ranges correspond to different levels of air quality.

For each pollutant, an appropriate air quality category is assigned, such as:

- Very Good – very low concentration

- Good – low concentration

- Moderate – medium concentration

- Poor – high concentration

V- ery Poor – very high concentration

Each of these levels is associated with a specific color (e.g., green for "Very Good" air quality, red for "Very Poor" air quality).

3. Determining the Dominant Pollutant

The Polish Air Quality Index is based on the pollutant that is most dominant in a given region at a specific time. This means that if, for example, PM10 has the highest concentration, it will have the most significant impact on the final index result.

4. Calculating the Index Result

In the final calculation of the PIJP, the dominant air quality indicator (the pollutant with the highest concentration) is used, as it has the most significant effect on the air quality in the region. The final result will represent one of the air quality levels, reflecting the influence of this dominant pollutant.

5. Presenting the Result

After calculating the index value, it is displayed as:

- A color-coded indicator on air quality maps,
- Information provided in applications, online services, and local media.

After a brief theoretical introduction, participants work with sample data on pollutant concentrations—Attachment No. 6. Their task is to find the PIJP threshold index in the table for each pollutant. They also identify the dominant pollutant and, based on this, determine the air quality level in the specified region. Each group receives different data (e.g., from a different province).

At the end, each group presents their results to the whole workshop. This is followed by a short discussion on air quality, including a presentation of the Environmental Protection Inspectorate's app ("Air Quality in Poland").

2.4. Calculating Percentage Differences in Air Quality between Poland and Germany – Individual Work (30 minutes)

The facilitator begins by presenting data on the state of air quality in Europe in 2024, based on a report prepared by the European Environment Agency ("Air Quality in Europe 2024") – Attachment No. 7.

Participants then work individually to calculate percentage differences in air quality between the partner countries, Poland and Germany. This exercise allows participants to apply percentage calculations in a practical context, comparing air quality data across regions in the two countries.

Participants work with Attachment No. 8. After completing their calculations (approximately 15 minutes), a group discussion follows—participants share their insights on the causes of air quality differences between Poland and Germany. The facilitator moderates the discussion, encouraging reflection on the impact of air pollution on human health and the environment.

2.5. Percentage Composition of Air and Unit Conversion – Group Work (20 minutes)

The facilitator provides participants with a simplified percentage composition of air:

- Nitrogen (78%)

- Oxygen (21%)

- Argon (0.9%)

- Carbon dioxide (0.05%)

- Other gases (0.05%)

.Based on this information, participants work in groups to calculate the volume of each air component in a room with specified dimensions—using Attachment No. 9. Then, each group converts the obtained values (in cubic meters) into corresponding volumes in liters. This task reinforces skills in unit conversion and provides practical application of air composition data in a real-world context.

As a summary, the facilitator reviews the calculations, explaining how the calculated volume of air components can impact practical applications in environmental protection, particularly in air quality analysis within various spaces (e.g., monitoring oxygen and carbon dioxide levels).

The facilitator encourages participants to ask questions about the application of these calculations in real-life situations, such as air quality control in enclosed spaces, ventilation, and the use of this data in ecological contexts.

2.6. Calculating the Percentage of Air Pollution in Different Cities – Group Work (20 minutes)

The facilitator presents data on PM2.5 and PM10 particle concentrations, which are indicators of air pollution levels —Attachment No. 10.

Participants will be divided into groups of 3-4 people. Each group will receive data on PM2.5 concentrations in three different cities: City A, City B, and City C—Attachment No. 11.

Each group will calculate the percentage of air pollution in each city using the formula provided by the facilitator.

In addition, each group will determine the mass of PM2.5 in a room with a volume of 100 m^3 based on the concentration levels in each city. Assume that the density of PM2.5 is 0.0015 kg/m^3.

Presentation of Results by Groups – Participants will present their calculated percentage of air pollution in each city and the mass of PM2.5 in a 100 m^3 room.

Groups will indicate which city has the highest pollution level and discuss any conclusions that can be drawn from these calculations.

3. Conclusion and Workshop Evaluation (10 minutes)

Objective: Allow participants to reflect on the knowledge gained and gather their feedback on the session.
Brief Evaluation Survey – Which information was most useful, and what would they like to develop further in the future?

Homework Assignments (for individual completion):

Homework Task 1: Mass of Air in a Room

In a room measuring 4 meters in length, 5 meters in width, and 3 meters in height, there is clean air. Calculate the mass of the air in this room, assuming an air density of 1.225 kg/m³.

Homework Task 2: Mass of Air in a Balloon

Task description: Calculate the mass of air in a balloon with a volume of 0.8 m³, assuming an air density of 1.225 kg/m³.

Homework Task 3: Mass of Air in a Room with Known Dimensions

Task Description: The room has dimensions of 6 meters in length, 4 meters in width, and 2.5 meters in height. Calculate the mass of the air in this room, assuming an air density of 1.225 kg/

Attachment No. 1 – Composition of Air

Air is a mixture of gases that forms the atmosphere around Earth. It is essential for the survival of humans, animals, and plants. Although it may appear empty at first glance, air is actually a very complex substance with specific dominant components.

Main Components of Air:

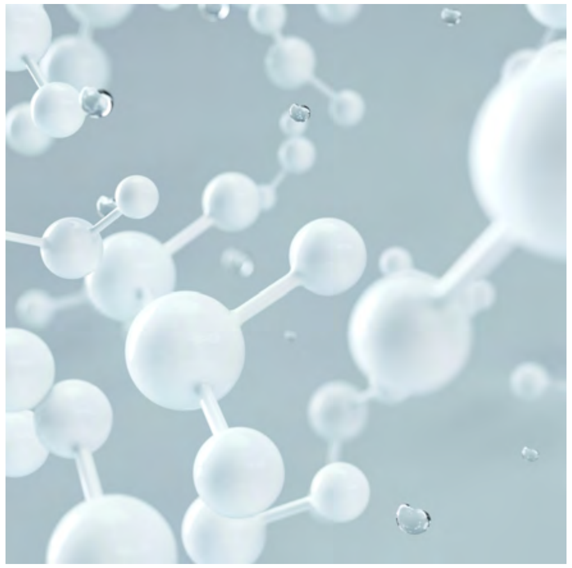
- Nitrogen (N_2) – 78%: Nitrogen makes up the largest portion of the atmosphere and is colorless, odorless, and chemically inert. Although it constitutes the majority of air, it is not directly used in biological processes, except by certain microorganisms that can fix it.

- Oxygen (O_2) – 21%: Oxygen is crucial for life on Earth, as it is used by aerobic organisms (including humans) for breathing and energy production (cellular respiration). Oxygen is also essential for combustion processes.

- Argon (Ar) – 0.93%: Argon is a noble gas that constitutes about 1% of air. It is colorless, odorless, and chemically inert. Although it has no significant impact on biological life, argon is used in industries such as welding.

- Carbon Dioxide (CO_2) – 0.04%: Carbon dioxide is a natural component of the atmosphere, playing an important role in biological processes (e.g., photosynthesis) and climate regulation (global warming). Although it makes up a small percentage of air, CO_2 has a major impact on climate change.

- Other Gases and Substances: Air also contains trace amounts of other gases, such as neon, helium, krypton, methane, and hydrogen, as well as water vapor. Water vapor in the atmosphere plays a crucial role in the hydrological cycle and weather processes.



Clean air refers to air that does not contain excessive levels of harmful substances, such as suspended particulates (PM2.5 and PM10), sulfur dioxide (SO_2), nitrogen oxides (NOx), ozone (O_3), or other chemical pollutants. Clean air is essential for the proper functioning of living organisms, including humans.

Clean air provides optimal conditions for breathing and supports the healthy growth of plants, which form the foundation of the food chain. This, in turn, positively affects human health by enhancing respiratory function, reducing the risk of heart disease, and improving overall quality of life.

Discussion Questions:

- Which gases dominate the air? Which of these are essential for life on Earth?

- What is clean air? What components must be present in the air for it to be considered clean?

- What is the importance of clean air for human health? What are the long-term consequences of prolonged exposure to polluted air?

Air pollution is the presence of harmful substances in the atmosphere that can negatively impact the health of humans, plants, animals, and the climate. The most common air pollutants include:

- Suspended Particulates (PM2.5 and PM10): These fine solid particles can penetrate deep into the lungs and even enter the bloodstream, leading to serious respiratory and cardiovascular diseases.

- Carbon Dioxide (CO_2): Although not directly harmful to health at low concentrations, CO_2 is the primary greenhouse gas responsible for climate change, contributing to the greenhouse effect.

- Nitrogen Oxides (NOx): Primarily produced from vehicle and industrial emissions, NOx contributes to smog formation and adversely affects respiratory health.

- Sulfur Dioxide (SO_2): Mostly from industrial sources, SO_2 can lead to acid rain, which damages vegetation and contaminates groundwater.

Discussion Questions:

- Which regions in Poland and Germany have the highest air pollution levels?

Poland: Air pollution is particularly high in regions like Silesia, Małopolska, and the Łódź Voivodeship.

Germany: In Germany, the cities with the highest air pollution levels are Frankfurt, Stuttgart, and Munich, where air pollution exceeds levels in other parts of the country.

- What are the most common sources of air pollution?

Burning of fossil fuels (coal, oil) in industry and transportation.

Wood burning in households.

Emissions from agriculture, especially from livestock farming.

Use of old heating stoves in homes.

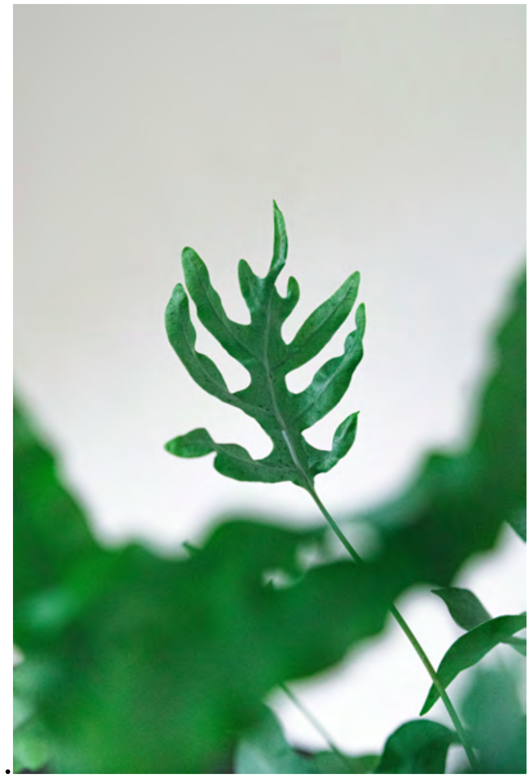
- What actions can help improve air quality?

Transitioning to renewable energy sources, such as solar and wind power.

Implementing regulations on vehicle and industrial emissions.

Expanding public transportation and cycling infrastructure.

Replacing old heating stoves with modern, more eco-friendly system.



Attachment No. 2 – Information on Regions in Poland and Germany with the Most Polluted and Cleanest Air

1. Poland:

Regions with the Most Polluted Air:

- Małopolska: This region regularly records high concentrations of PM10 and PM2.5 particulates, especially during the heating season. Kraków, the capital of Małopolska, often ranks among the most polluted cities in Poland.

- Silesia: This region struggles with smog year-round, mainly due to the coal and energy industries and heavy road traffic. In cities like Katowice and Sosnowiec, air quality standards are frequently exceeded.

Regions with the Cleanest Air:

- Podlasie: This region has low air pollution levels, primarily due to its extensive forest areas and low urbanization. Cities like Suwałki and Białystok report better air quality compared to other regions.

- Pomerania: Thanks to its proximity to the sea and abundance of green areas, this region enjoys cleaner air. Gdańsk and Gdynia consistently record better air quality indicators.

2. Germany:

Regions with the Most Polluted Air:

- North Rhine-Westphalia: As the most densely populated state in Germany, with significant industry and traffic, this region experiences high levels of air pollution. Cities like Essen and Duisburg frequently exceed air quality standards.

- Bavaria: Despite a large number of green areas, Bavaria struggles with smog issues, especially in cities like Munich, where emissions from transportation and industry impact air quality.

Regions with the Cleanest Air:

- Saxony: This region has low air pollution levels, largely due to extensive forested areas and low urbanization. Cities like Dresden and Leipzig consistently record better air quality indicators.

- Schleswig-Holstein: Due to its proximity to the sea and abundant green areas, this region enjoys cleaner air. Cities like Lübeck and Flensburg consistently record better air quality indicators.

Proposed Actions to Improve Air Quality:

- Promoting Public Transport: Investing in the expansion and modernization of public transport networks to encourage residents to use more eco-friendly transportation options.

- Developing Cycling Infrastructure: Building and upgrading bike lanes and city bike stations to promote a healthy and environmentally friendly way to navigate urban areas.

- Supporting E-mobility: Providing subsidies and tax incentives for individuals and companies investing in electric vehicles, along with developing charging infrastructure.

- Environmental Education: Conducting informational campaigns on the impact of air pollution on health and the environment, and promoting eco-friendly attitudes among citizens.

Attachment No. 3 – Basic Definitions: Volume, Mass, Density

Volume is a measure of the space occupied by an object or substance. We can discuss the volume of solids (e.g., a box), liquids (e.g., water in a glass), and gases (e.g., air in a balloon).

In metric units, volume is measured in cubic meters (m^3) or liters (L).

$$1 \text{ m}^3 = 1000 \text{ liters}$$

Mass is the amount of matter contained in an object or substance. Mass tells us how much "stuff" is present in a given object. Generally, an object's mass is greater if it contains more material.

Metric units for mass include kilograms (kg), grams (g), tons (t), etc.

How to Calculate Mass? Mass depends on the volume of the object and the density of the substance it is made of. The greater the volume and the density, the greater the mass.

Density is a measure of how "heavy" a substance is relative to its volume. It indicates the amount of mass contained in a unit of volume. In other words, density tells us how much material is present within a given space.

Density is typically expressed in kilograms per cubic meter (kg/m^3) or grams per cubic centimeter (g/cm^3). 1 kg/m^3 is equal to 0.001 g/cm^3.

Relationships Between Volume, Mass, and Density

These three concepts—volume, mass, and density—are closely interconnected. If you know two of them, you can easily calculate the third. Here are the main relationships:

Calculating Mass: If you know the volume and density, you can calculate mass using the formula:

$$\text{Mass} = \text{Volume} \times \text{Density}$$

Calculating Volume: If you know the mass and density, you can calculate volume using the formula:

$$\text{Volume} = \text{Density}/\text{Mass}$$

Calculating Density: If you know the mass and volume, you can calculate density using the formula:

$$\text{Density} = \text{Volume}/\text{Mass}$$

Example with Air:

If we have a balloon with a volume of 10 m^3, the mass of the air in that balloon is calculated as follows:

Air Density: 1.225 kg/m^3

Balloon Volume: 10 m^3

Calculating the mass of air:

Mass of air$=1.225\text{kg/m}3\times10\text{m}3=12.25\text{kg}$

Therefore, the mass of the air in a balloon with a volume of 10 m^3 is 12.25 kg.

Summary:

Volume tells us how much space an object or substance occupies.

Mass is the amount of matter in an object or substance.

Density is the ratio of mass to volume and indicates how "heavy" a substance is within a given volume.

These three concepts (volume, mass, density) are essential when analyzing air, water, and other substances in everyday life. They also hold great significance in ecological calculations, such as analyzing the mass of air in enclosed spaces.

Attachment No. 4 – Calculating the Volume and Mass of Air in a Room

Let us recall that the volume of a room (rectangular prism) can be calculated using the formula:

$$Volume = Length \times Width \times Height$$

where length, width, and height are in meters (m), and the result will be in cubic meters (m^3).

Similarly, the mass of the air can be calculated using the formula:

$$Mass = Volume \times Density$$

where the density of air is approximately 1.225 kg/m^3 (at 15°C at sea level).

Example:

Let's assume we have a room with the following dimensions:

Length: 6 m

Width: 4 m

Height: 2.5 m

Calculating the volume of air in the room:

$$V = 6m \times 4m \times 2.5m = 60m3$$

Calculating the mass of air in this room:

$$m = V \times density$$

$$m = 60m3 \times 1.225kg/m3 = 73.5kg$$

The mass of the air in a room with the given dimensions is 73.5 kg.

Additional Example to Solve:

Room A:

Length: 8 m

Width: 5 m

Height: 3 m

Room B:

Length: 4.5 m

Width: 3.5 m

Height: 3 m

Room C:

Length: 750 cm (convert to meters: 7.5 m)

Width: 30 dm (convert to meters: 3 m)

Height: 2.5 m

Note: Remember to standardize units by converting any measurements in centimeters or decimeters to meters.

After completing the calculations, the facilitator poses discussion questions to prompt participants to reflect on the practical aspects of air quality and its impact on human health and the environment.

Discussion Questions:

- What is the importance of air quality for human health? (e.g., respiratory diseases, allergies, asthma)
- What consequences can air pollutants, such as smog, have on public health and the natural environment?
- What actions can help improve air quality in our homes and cities? (e.g., changing heating methods, reducing emissions from transportation, transitioning to renewable energy sources)
- How can the calculated values of air mass help in analyzing air quality? What steps could we take to improve these values in cities with the most polluted air?

Attachment No. 5 – Calculating the Mass of Air in 70 Balloons

Preliminary Information:

Air density is approximately 1.225 kg/m³ (at a temperature of 15°C at sea level).

Volume of each balloon is 10 liters, or 0.01 m³.

Number of balloons: 70 balloons.

Participants begin by calculating the mass of air in one balloon. To do this, they should use the formula:

Mass=Volume×Density

Volume = 0.01 m³ (volume of one balloon)

Density = 1.225 kg/m³ (density of air)

Calculations:

....

....

Calculating the Mass of Air in 70 Balloons:

....

....

Converting Units (from kilograms to grams):

....

....

Attachment No. 6 – Introduction to the Algorithm for Calculating the Polish Air Quality Index (PIJP) – Group Work

Sample Data (Silesia):

PM10: 75 µg/m³

PM2.5: 45 µg/m³

NO_2: 45 µg/m³

CO: 0.9 mg/m³

O_3: 50 µg/m³

SO_2: 10 µg/m³

Group Task (15 minutes):
Step 1: Participants start by analyzing the data and finding the PIJP threshold levels for each air pollutant in the table.

Step 2: Participants assign an appropriate air quality category for each pollutant based on its concentration (e.g., PM10 – concentration of 75 µg/m³, which, according to the table, may correspond to the "Poor" level).

Step 3: After assigning an air quality category to each pollutant, the groups determine which pollutant dominates in the region. This means that the pollutant with the highest concentration will have the greatest impact on the PIJP result.

Step 4: Based on the dominant pollutant, groups determine the overall air quality in the region (e.g., if the dominant pollutant is PM10 with a high concentration, the PIJP result may correspond to the "Poor" category).

For PM10 (75 µg/m³) – level ....

For PM2.5 (45 µg/m³) – level ....

For NO_2 (45 µg/m³) – level ....

For CO (0.9 mg/m³) – level ....

For O_3 (50 µg/m³) – level ....

For SO_2 (10 µg/m³) – level ....

The dominant pollutant in this case is PM10 with a level of ……………………., so the PIJP result will be ……………………..

Summary of Results (5 minutes):
Each group presents its findings to the forum:

- What were the concentrations of each pollutant?

- Which pollutant was dominant?

- What air quality category did they assign to their region?

After the presentations, the facilitator gathers insights, emphasizing the importance of air quality analysis in different regions of Poland and Germany and its implications for residents' health.

Discussion Questions:

- What health benefits result from improved air quality?

- What actions could be taken to improve air quality in the most polluted regions of Poland?

Data for Groups:

Silesia, Poland

PM10: 75 µg/m³

PM2.5: 45 µg/m³

NO_2: 45 µg/m³

CO: 0.9 mg/m³

O_3: 50 µg/m³

SO_2: 10 µg/m³

Małopolska, Poland

PM10: 65 µg/m³

PM2.5: 40 µg/m³

NO_2: 40 µg/m³

CO: 0.8 mg/m³

O_3: 55 µg/m³

SO_2: 12 µg/m³

Data for Groups:

Pomerania, Poland

PM10: 50 µg/m³

PM2.5: 30 µg/m³

NO_2: 35 µg/m³

CO: 0.7 mg/m³

O_3: 60 µg/m³

SO_2: 8 µg/m³

Bavaria, Germany

PM10: 60 µg/m³

PM2.5: 35 µg/m³

NO_2: 50 µg/m³

CO: 0.9 mg/m³

O_3: 55 µg/m³

SO_2: 10 µg/m³

5. Rhineland-Palatinate, Germany

PM10: 55 µg/m³

PM2.5: 33 µg/m³

NO_2: 45 µg/m³

CO: 0.8 mg/m³

O_3: 58 µg/m³

SO_2: 9 µg/m³

These data illustrate the differences in air pollution levels across various regions. Notably, regions such as Silesia and Małopolska in Poland, as well as Bavaria in Germany, show higher concentrations of particulate matter PM10 and PM2.5.

Data Sources:

Main Inspectorate of Environmental Protection (GIOŚ) – air quality data for Poland.

Federal Environment Agency (Umweltbundesamt) – air quality data for Germany.

PIJP Threshold Table

1. PM10 (Particulate Matter with a Diameter up to 10 µm)

Very Good Air Quality: PM10 concentration ≤ 30 µg/m³

Good Air Quality: 31 µg/m³ ≤ PM10 concentration ≤ 50 µg/m³

Moderate Air Quality: 51 µg/m³ ≤ PM10 concentration ≤ 75 µg/m³

Poor Air Quality: 76 µg/m³ ≤ PM10 concentration ≤ 100 µg/m³

Very Poor Air Quality: PM10 concentration > 100 µg/m³

2. PM2.5 (Particulate Matter with a Diameter up to 2.5 µm)

Very Good Air Quality: PM2.5 concentration ≤ 15 µg/m³

Good Air Quality: 16 µg/m³ ≤ PM2.5 concentration ≤ 25 µg/m³

Moderate Air Quality: 26 µg/m³ ≤ PM2.5 concentration ≤ 35 µg/m³

Poor Air Quality: 36 µg/m³ ≤ PM2.5 concentration ≤ 50 µg/m³

Very Poor Air Quality: PM2.5 concentration > 50 µg/m³

3. NO_2 (Nitrogen Dioxide)

Very Good Air Quality: NO_2 concentration ≤ 40 µg/m³

Good Air Quality: 41 µg/m³ ≤ NO_2 concentration ≤ 60 µg/m³

Moderate Air Quality: 61 µg/m³ ≤ NO_2 concentration ≤ 80 µg/m³

Poor Air Quality: 81 µg/m³ ≤ NO_2 concentration ≤ 100 µg/m³

Very Poor Air Quality: NO_2 concentration > 100 µg/m³

4. CO (Carbon Monoxide)

Very Good Air Quality: CO concentration ≤ 0.5 mg/m³

Good Air Quality: 0.51 mg/m³ ≤ CO concentration ≤ 1 mg/m³

Moderate Air Quality: 1.1 mg/m³ ≤ CO concentration ≤ 2 mg/m

Poor air quality: 2.1 mg/m³ ≤ CO concentration ≤ 5 mg/m³

Very poor air quality: CO concentration > 5 mg/m³

5. O_3 (Ozone)

Very good air quality: O_3 concentration ≤ 50 µg/m³

Good air quality: 51 µg/m³ ≤ O_3 concentration ≤ 100 µg/m³

Moderate air quality: 101 µg/m³ ≤ O_3 concentration ≤ 150 µg/m³

Poor air quality: 151 µg/m³ ≤ O_3 concentration ≤ 200 µg/m³

Very poor air quality: O_3 concentration > 200 µg/m³

6. SO_2 (Sulfur Dioxide)

Very good air quality: SO_2 concentration ≤ 25 µg/m³

Good air quality: 26 µg/m³ ≤ SO_2 concentration ≤ 50 µg/m³

Moderate air quality: 51 µg/m³ ≤ SO_2 concentration ≤ 100 µg/m³

Poor air quality: 101 µg/m³ ≤ SO_2 concentration ≤ 150 µg/m³

Very poor air quality: SO_2 concentration > 150 µg/m³

The Polish Air Quality Index (PIJP) is used to assess air quality in Poland based on the concentration of six main air pollutants.

Air quality thresholds depend on pollutant concentrations, ranging from very good air quality (very low concentration) to very poor air quality (very high concentration).

The dominant pollutant in a region significantly impacts the final PIJP result.

We encourage you to download the "Air Quality in Poland" app, available here: https://powietrze.gios.gov.pl/pjp/content/show/1001197

Annex No. 7 – Air Quality Status in Europe in 2024

In 2024, the European Environment Agency published the report "Air Quality in Europe 2024," which presents the current air quality status across European countries.

The report was prepared based on data collected in 2022 and 2023, analyzing concentrations of key air pollutants and their impact on public health.

Key findings from the Report:

1. Main Air Pollutants in Europe:

- PM2.5 (Particulate Matter with a diameter up to 2.5 µm): In 2022, 96% of the urban population in the EU was exposed to PM2.5 concentrations exceeding the World Health Organization (WHO) guideline level of 5 µg/m³. By comparison, this percentage was 97% in 2019.

- Ozone (O_3): In 2022, 94% of the urban population was exposed to ozone concentrations exceeding the WHO's recommended average 8-hour concentration of 100 µg/m³. In 2019, this percentage was 99%.

2. Regions with the Poorest Air Quality:

- Poland: In 2022, Poland recorded the highest concentrations of benzo(a)pyrene in Europe. In 32 out of 46 zones across 15 of Poland's 16 provinces, B(a)P concentrations exceeded the permissible standards. Additionally, annual PM2.5 limits were surpassed in 45 out of 46 zones.

- Italy: Northern Italy reported high levels of PM10, primarily due to the use of solid fuels in households and specific meteorological and geographical conditions.

3. Regions with the Best Air Quality:

- Scandinavia: Norway, Sweden, and Finland have some of the best air quality in Europe. PM2.5 concentrations are significantly below the European average, and residents are less frequently exposed to high pollutant levels, such as ozone. For instance, in Oslo, the average

PM2.5 concentration in 2022 was 3 μg/m³, which is well below the WHO's recommended limits.

- Iceland: Similar to Scandinavia, Iceland boasts excellent air quality. The country's lack of heavy industry and low population density contribute to reduced pollutant emissions. Additionally, Iceland does not face significant issues related to particulate pollution.

4. Major Challenges in the Fight for Cleaner Air:

In major urban centers (e.g., Warsaw, Kraków, and Prague), air pollution largely originates from transportation. This is particularly true for nitrogen oxides (NO_2) and particulate matter (PM10 and PM2.5), which primarily stem from combustion engine emissions.

One of the biggest challenges in improving air quality in these cities is the shift to electric transportation and reducing emissions from personal vehicles.

During the heating season, especially in Poland and other Central and Eastern European countries, air quality is heavily impacted by emissions from household heating using solid fuels (coal, wood, biomass). In regions like Silesia, where coal is still widely used for home heating, significant emissions of particulate matter and carbon dioxide are observed.

Proposed Solutions for Combating Air Pollution:

Reducing Vehicle Emissions: Promoting public transportation, expanding tram and bus networks, and offering tax incentives for purchasing electric vehicles could reduce exhaust emissions.

Investing in Renewable Energy Sources: Increased investment in renewable energy sources, such as solar, wind, and geothermal energy, which do not emit air pollutants, could contribute significantly to reducing air pollution.

- Educating the public on the effects of air pollution and promoting eco-friendly practices in households—such as replacing old coal stoves with modern, eco-friendly boilers, practicing waste segregation, reducing the use of personal cars, and shifting to public transportation—is crucial. Implementing educational programs that encourage the use of renewable energy, sustainable urban development, and the expansion of electromobility in both urban and rural areas is also essential.

These initiatives aim to increase awareness and support the adoption of green solutions across communities.

Air quality in Europe, including in Poland and Germany, varies by region, and improving air quality remains a significant challenge. High concentrations of air pollutants, especially in large cities, have a direct impact on residents' health, leading to respiratory diseases, cardiovascular issues, and cancers. Actions aimed at reducing particulate emissions, greenhouse gases, as well as developing renewable energy sources and promoting public transportation can contribute to improving air quality.

Sources:

European Environment Agency (EEA) – Report "Air Quality in Europe 2024"

Portal: https://mappingair.meteo.uni.wroc.pl/2024/07/stan-jakosci-powietrza-w-europie-w-2024-roku

Chief Inspectorate of Environmental Protection (GIOŚ) – Air quality monitoring in Poland

Annex No. 8 – Calculating Percentage Differences in Air Quality between Poland and Germany

The facilitator begins by introducing participants to the air quality data for Poland and Germany in 2024 (Annex No. 7). Together, they discuss which air pollutants will be compared (PM2.5, PM10, NO_2, CO, O_3, SO_2) and what each unit of concentration means (µg/m³, mg/m³).

Step 2: Preparing Data for Calculations

Data for calculations for Poland and Germany:

Poland:

PM10: 75 µg/m³

PM2.5: 45 µg/m³

NO_2: 45 µg/m³

CO: 0.9 mg/m³

O_3: 50 µg/m³

SO_2: 10 µg/m³

Germany:

PM10: 60 µg/m³

PM2.5: 35 µg/m³

NO_2: 40 µg/m³

CO: 0.8 mg/m³

O_3: 55 µg/m³

SO_2: 9 µg/m³

Step 3: Calculating Percentage Differences

Instructions for Participants:

Calculating the percentage difference in pollutant concentration (e.g., PM10):

Formula:

Percentage Difference=Concentration in GermanyConcentration in Poland−Concentration in Germany ×100%

Example for PM10:

Percentage difference = (75 − 60) × 100% / 60 = 25%
This means that the PM10 concentration in Poland is 25% higher than in Germany.

Participants perform similar calculations for the remaining air pollutants (PM2.5, NO_2, CO, O_3, SO_2).

Calculating the percentage difference for the remaining pollutants:

PM2.5

....

NO_2

....

CO

....

O_3

....

SO_2

....

SO_2

....

After completing the calculations, participants share their results in groups, discussing:

- Why are the differences in air quality between Poland and Germany so noticeable?

- To what extent do emissions from industry, transportation, and building heating impact these differences?

- What geographical factors, such as location, climate, population density, and industrial development, might influence air quality?

- What actions could improve air quality?

- Replacement of coal stoves, changes in public transportation, development of renewable energy sources, and reduction of industrial emissions—among these actions, which might be most effective in Poland and Germany?

Annex No. 9 – Calculating the Volume of Air Components in a Room with Given Dimensions and Unit Conversion

Step 1: Introducing Participants to the Data

The facilitator presents the percentage composition of air to the participants:

Nitrogen (78%)

Oxygen (21%)

Argon (0.9%)

Carbon Dioxide (0.05%)

Other Gases (0.05%)

The facilitator emphasizes that these values represent the percentage composition of air, meaning that summing all percentages will yield 100%. They also explain how to calculate the volumes of air components based on their percentage shares.

Step 2: Calculating the Volume of Air Components

The facilitator gives a task in which participants are to calculate the volume of individual air components in a room with given dimensions. Example:

Room Dimensions:

Length: 6 m

Width: 5 m

Height: 3 m

Calculating the Total Volume of the Room:

……………………………………………………………………

……………………………………………………………………

The facilitator then explains how to calculate the volume of each air component. For example, to calculate the volume of nitrogen (78% of the air volume):

Volume of Nitrogen=Total Volume of the Room×78%= Total Volume of the Room×0.78

Similarly, participants perform calculations for all air components:

Nitrogen (78%)

....

....

Oxygen (21%)

....

....

Argon (0.9%)

....

....

Carbon Dioxide (0.05%)

....

....

Other Gases (0.05%)

....

....

Step 3: Converting Units from Cubic Meters to Liters

The facilitator reminds that: 1 m^3 = 1000 liters

Based on this, participants convert the calculated volumes from cubic meters (m^3) to liters (l):

Nitrogen:

....

Oxygen:

....

Argon:

....

Carbon Dioxide:

....

Other Gases:

....

Annex No. 10 – PM2.5 and PM10 Concentrations as Indicators of Air Pollution

1. Introduction to PM2.5 and PM10 Particulate Matter

Particulate matter (PM) consists of microscopic solid particles or liquid droplets suspended in the air. Based on their size, they are categorized as follows:

PM10: Particles with a diameter of up to 10 micrometers.

PM2.5: Particles with a diameter of up to 2.5 micrometers.

Due to their small size, PM2.5 and PM10 particles are particularly hazardous to health, as they can penetrate deep into the respiratory system and even enter the bloodstream.

2. Main Sources of PM2.5 and PM10 Particulate Matter:

- Transportation Emissions – vehicle exhaust, especially from diesel engines,

- Industry – production processes, burning of fossil fuels,

- Building Heating – burning of coal, wood, and other solid fuels in household stoves,

- Agriculture – burning of crop residues, farming activities,

- Natural Sources – desert dust, volcanic eruptions.

3. Health Impact

Long-term exposure to high concentrations of PM2.5 and PM10 can lead to:

- Respiratory diseases, such as asthma and chronic obstructive pulmonary disease (COPD),

- Heart diseases,

- Lung cancer,

- Accelerated aging of lung tissue.

4. Air Quality Standards

According to the standards set by the World Health Organization (WHO) and the European Union (EU):

PM2.5:

Annual average concentration: WHO – 5 μg/m³, EU – 10 μg/m³

Daily concentration: WHO – 15 μg/m³

PM10:

Annual average concentration: WHO – 15 μg/m³, EU – 40 μg/m³

Daily concentration: WHO – 45 μg/m³, EU – 50 μg/m³

In Poland, these standards align with EU standards.

5. Air Quality Monitoring

In Poland, tools are available for monitoring air quality, such as the Airly application, which provides real-time data on particulate matter concentrations across different regions of the country.

6. Actions to Improve Air Quality

To enhance air quality, it is recommended to:

- Replace old coal stoves with modern, eco-friendly boilers.

- Develop public transportation and electromobility.

- Reduce industrial emissions by adopting modern technologies.

- Promote renewable energy sources.

- Implementing these actions will contribute to improved air quality and the health of residents.

Sources:

- Airly – Air Quality Monitoring in Poland and Worldwide.

- European Environment Agency (EEA) – "Air Quality in Europe 2024" Report.

Annex No. 11 – Calculating PM2.5 Air Pollution in Three Cities

Step 1:

The facilitator divides participants into groups of 3–4 people. Each group receives data on PM2.5 concentrations in three cities:

City A: 35 $\mu g/m^3$

City B: 50 $\mu g/m^3$

City C: 45 $\mu g/m^3$

The facilitator reminds participants of the formula for calculating air pollution as a percentage. Air pollution is expressed as a percentage relative to the standard set by the WHO or other authorities responsible for air quality.

Assume that the 24-hour PM2.5 concentration standard is 25 $\mu g/m^3$ (as per WHO recommendations).

The percentage air pollution in a given city is calculated using the formula:

Percentage Pollution=WHO PM2.5 StandardPM2.5 Concentration in the City$\times$100%

Calculations:

City A:

Percentage Pollution =

....

....

City B:

Percentage Pollution =

....

....

City C:

Percentage Pollution =

....

....

Step 2: Calculating the Mass of PM2.5 in the Air in a Room with a Volume of 100 m^3

The facilitator provides the formula for calculating the mass of PM2.5 in a given room:

Mass of PM2.5=Room Volume×PM2.5 Concentration× PM2.5 Density

Assumptions:

Room Volume = 100 m^3

PM2.5 Density = 0.0015 kg/m^3 (provided by the facilitator)

Calculations:

City A:

....

....

City B:

....

....

City C:

....

....

After completing the calculations, each group discusses:

- Which city has the highest air pollution? (City B).

- What conclusions can be drawn from these calculations?

City B has the highest PM2.5 concentration, indicating that the air in this city is the most polluted.

Higher concentrations of particulate matter are associated with greater health risks, especially in the long term.

It may be beneficial to consider implementing measures to reduce pollution emissions in regions with high PM2.5 concentrations, such as City B.

Scenario No. 8

"Do you know how to create your own compost?"

Workshop Objective:

- Learn how to independently create compost using basic mathematical skills such as calculating volume, solving proportions, and computing percentages.
- Understand the process of compost creation and its environmental benefits.
- Apply mathematical skills to calculate volume, solve proportions, and compute percentages in the context of composting.

Duration: 3 hours.

Required Materials

- Dry-erase boards and markers for recording group task results and calculations.
- Calculators for each participant to handle more complex calculations.
- Attachments 1 Debunking Composting Myths
- Attachments 2 Why Composting Matters
- Attachments 3 Proportions in Composting
- Attachments 4 Proportions in Daily Life
- Attachments 5 Proportions in Effective Composting – Practical Application
- Attachments 6 Proportions in Daily Life – Practical Application
- Attachments 7 Instructions for Preparing a Container for Your Own Home Compost Bin
- Attachments 8 List of Compostable Waste
- Materials for the practical group activity of creating a home compost bin, including: a used paint bucket: a drill (or another tool for making holes), mesh (e.g., with small openings), scissors, adhesive tape, odor filter (e.g., activated carbon), protective gloves, marker

Workshop Plan:

1. Introduction to the Workshop Topic (20 minutes)

Discussion on Air Composition:

The facilitator begins a discussion about myths related to composting.
Here are a few initial questions:

- Who among you has ever thought about composting but decided it was too difficult, inconvenient, or… smelly?
- Are there any participants here who have tried composting in an apartment building and encountered problems?

Today, we will debunk some myths about composting and show that it is, in fact, a very simple way to live sustainably—whether you have a garden, a balcony, or just a kitchen in your apartment.
We will learn how to set up a compost bin that doesn't produce unpleasant odors and discover how composting can bring benefits to everyday life.

Next, the facilitator presents the goal of the workshop:
Our workshop will be divided into two parts:

- In the first part, we will discuss the basics of composting, debunk some popular myths, and learn why proportions are key.
- In the second, practical part, we will prepare a simple home compost bin together, which each of you will be able to use at home. Along the way, we will introduce and practice the concept of proportions—this is a great opportunity to refresh basic mathematical skills that have very practical applications!

Next, the facilitator conducts a brief group discussion to address myths about composting using Attachment No. 1 (Debunking Myths About Composting). The following myths are discussed in the form of a group debate:

- Composting smells bad.
- Composting is only for people with gardens.
- Composting requires a lot of time and effort.
- Composting in an apartment building attracts insects and rodents

- Composting requires expensive equipment.
- Composting requires specialized knowledge.
- Composting can only be done in the summer.
- Anything organic can be thrown into the compost.

The final element of the introduction is familiarizing the group with the benefits of maintaining a compost bin. The facilitator presents Attachment No. 2 (Why Composting Matters) and, in a conversational style, highlights the benefits of composting, including:

- Composting introduces principles of ecology and sustainable development into your life (understanding the natural cycle, conscious waste management, and resource conservation).
- Composting significantly reduces the amount of waste (up to 30% of waste from our kitchens consists of materials suitable for composting!).
- Composting creates free and natural fertilizer (improves soil quality, provides a natural alternative to chemicals, and reduces resource waste).
- Composting supports the natural environment (reduces greenhouse gas emissions, decreases the need for industrial fertilizers, and protects biodiversity).
- Composting saves money (lower waste disposal costs, savings on fertilizers, and more efficient crop yields).
- Composting offers education and satisfaction (observing natural processes, a sense of accomplishment, and engaging others).
- Composting enhances the aesthetics and health of potted plants (healthier plants and reduced need for chemical treatments).

The facilitator asks the seniors if they know of any additional benefits of composting.

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. On Proportions in Composting (20 minutes)

In the introductory part of the workshop, we discussed the benefits of composting, but what exactly is composting?

Composting is a natural process of breaking down organic matter, resulting in compost—a dark, fertile material resembling soil, rich in nutrients.
Through composting, we can transform kitchen and garden waste into a valuable fertilizer that is environmentally friendly and supports healthy plant growth.

Composting is essentially the work of microorganisms, fungi, and small organisms that decompose organic residues into their basic components. However, for these microorganisms to work efficiently, they need the right conditions—most importantly, the proper proportion of materials.

Next, the facilitator presents Attachment No. 3 (Proportions in Composting) to the participants and introduces the topic:

Why Are Proportions Important?
The key to effective composting lies in the correct ratio of two groups of materials:

- "Green" materials (rich in nitrogen):

- Vegetable scraps, fruit peels, coffee grounds, tea leaves, fresh grass clippings.

These are a source of nitrogen, which supports the growth of microorganisms responsible for decomposition.

- "Brown" materials (rich in carbon):

- Dry leaves, cardboard, paper, sawdust, straw.

- These provide energy for microorganisms, helping stabilize the composting process.

What Happens When Proportions Are Incorrect?

- Too much "green" material (nitrogen):
  This will make the compost too wet and sticky, and a lack of proper aeration may result in unpleasant odors (e.g., the smell of ammonia).

- Too much "brown" material (carbon):
  This will slow down the decomposition process, make the compost dry, and microorganisms will struggle to break down the materials.

The Ideal Proportion:
The carbon-to-nitrogen ratio in compost should be approximately 25:1 to 30:1. This means for every 25–30 parts of carbon, there should be 1 part of nitrogen. Practically, this translates to adding 2–3 parts of "brown" materials for every 1 part of "green" materials.

What Is a Proportion?

A proportion is a mathematical relationship between two or more quantities. In the case of composting, we use proportions to determine how much "brown" and "green" material to add in order to maintain the correct balance.

Example of a Proportion:
Imagine you have 1 kg of vegetable peels ("green" material). If the carbon-to-nitrogen ratio should be 30:1, you need to add:

30 times more carbon (e.g., dry leaves) relative to the nitrogen content in the peels.

In practice, you don't need to measure everything precisely—using simple visual guidelines is usually sufficient.

How to "Solve" Proportions in Practical Composting?
Example:
You have 1 bucket of "green" materials (e.g., vegetable peels).
You want to achieve a 3:1 ratio, meaning you need to add 3 buckets of "brown" materials for every 1 bucket of "green" materials.

Step 1: Check What You Have Available.

- If you have a lot of dry leaves, use them as "brown" material.

- If you have more grass clippings and peels, balance them by adding more newspaper, cardboard, or sawdust.

Step 2: Visual Assessment.

- "Green" materials are often wet and heavy, so 1 part of "green" material visually may equal a larger amount of "brown" materials, which are dry and lightweight.

Step 3: Moisture Test.

- If the compost is too wet, add more "brown" materials.
- If the compost is dry and the process is slow, add more "green" materials and possibly a bit of water.

How Does This Look in Everyday Practice?
You don't need to be a chemist or mathematician to compost effectively! While understanding proportions and how to apply them is useful, these skills are helpful not just in planning the composting process but also in everyday life.

2.2. On the Use of Proportions in Everyday Life (20 minutes)

Introduction: What Is a Proportion in Mathematics? (5 minutes)
A proportion is a way of expressing equality between two ratios. In other words, a proportion shows that two different quantities are in the same relative relationship to each other.

Mathematical Example:
If 2 apples cost 4 zł, and 4 apples cost 8 zł, we can write the proportion as:
2:4 = 4:8
This means the ratio of the number of apples to the price is the same in both cases.

In Equation Form, Proportions Look Like This:
2/4 = 4/8

Proportions help us compare different values in a fair and understandable way. This makes it easy to calculate unknown values, such as figuring out how much 10 apples will cost if we know the price of 2

How Are Proportions Solved?

Solving proportions involves finding the missing value in a proportion equation. We use cross-multiplication for this (multiply the numerator of the first fraction by the denominator of the second fraction, and compare it to the product of the denominator of the first fraction and the numerator of the second fraction).

Example 1: Buying Apples
We know that 2 apples cost 4 zł. We want to calculate how much 10 apples will cost.

Write the proportion:
2/4 = 10/x

We cross-multiply:

$2 \cdot x = 4 \cdot 10$

$2x = 40$

Answer: 10 apples cost 20 zł.

Example 2: Mixing Paint

To paint a wall, we use the proportion: for every 2 liters of white paint, we add 0.5 liters of colorant. How much colorant do we need if we have 8 liters of white paint?

Write the proportion:

2/0,5 = 8/x

We cross-multiply:

$2 \cdot x = 0{,}5 \cdot 8$

$2x = 4$

$x = 2$

Answer: We need 2 liters of colorant.

Practical Applications of Proportions in Everyday Life (10 minutes)

The facilitator, using Attachment No. 4 (Proportions in Everyday Life), presents the group with examples of practical applications of proportions in daily activities, including:

- Cooking and recipes:
  Adjusting recipes when increasing or decreasing the number of servings (e.g., scaling a recipe for a different number of people).

- Budget planning:
  Calculating monthly average expenses based on weekly or daily spending.

- Shopping and price comparisons:
  Comparing product prices for different package sizes to determine the best value.

- Medication dosing:
  Calculating the appropriate dosage of medication for an individual based on body weight.

- Travel:
  Estimating distances and fuel consumption for a trip.

Summary and Group Exercise (5 minutes)

At the end of the workshop session, the facilitator presents participants with 3 tasks (from Attachment No. 4). The group solves these tasks together, writing the appropriate calculations on the board:

- Adjusting recipe ingredients for a larger group of guests.

- Calculating trip costs based on a known unit cost (e.g., cost per kilometer of fuel).

- Comparing unit prices of products in a store.

2.3. Practical Problem-Solving with Proportions – Group Work (25 minutes)

The facilitator divides the participants into smaller teams (3–4 people in each group). The groups work with Attachment No. 5 (Proportions in Effective Composting – Practice), solving 5 examples that require the application of proportions and percentage calculations.

Time for Group Task Completion: 20 Minutes

After the allotted time, each group presents one solution, explains their method, and shares the result (writing the proportion on a board/flip chart).

Summary:
The facilitator leads a discussion, highlighting examples of where proportions and percentages are commonly encountered in everyday life and how they can be useful in various situations.

2.4. Practical Problem-Solving with Proportions – Group Work (15 minutes)

Participants work independently and may use basic calculators for assistance. They solve 8 simple tasks provided in Attachment No. 6 (Proportions in Everyday Life – Practice).

The tasks cover the following topics:

- cooking for a larger number of people,
- travel costs,
- purchasing by weight,
- composting in an apartment building,
- percentages in compost,
- price comparison in a store,
- medication dosing,
- diluting a cleaning agent.

After completing the tasks, participants discuss their results in an open forum. A brief debate follows: Have you ever used proportions in these everyday situations before (even unconsciously)?

2.5. Preparing Your Own Home Compost Bin – Group Work (60 minutes)

Each group prepares an inexpensive yet effective compost bin suitable for indoor use.

Materials: a used paint bucket, a drill (or another tool for making holes), mesh (e.g., with small openings), scissors, adhesive tape, odor filter (e.g., activated carbon), protective gloves, marker, attachment No. 7 – Instructions for Preparing Your Own Home Compost Bin.

The groups present their compost bins and discuss their potential uses, referencing Attachment No. 8 (List of Compostable Waste) to highlight the types of materials that can be composted.

3. Conclusion and Workshop Evaluation (10 minutes)

Objective: To allow participants to reflect on the knowledge gained and gather their feedback on the session.

A short evaluation survey – which information was the most useful, and what they would like to develop further in the future.

Homework (to be completed independently by participants):

Homework Task 1:

To prepare fertilizer for plants, mix 2 parts of compost with 1 part of water.
You have 8 liters of water. How many liters of compost do you need to add to maintain the proportion?

Homework Task 2:
A pancake recipe requires:

- 300 ml of milk,
- 2 eggs,
- 100 g of flour.

The recipe serves 4 people.

How much of each ingredient will you need if you want to prepare pancakes for 7 people?

Homework Task 3:

A car uses 7 liters of fuel per 100 km. You are planning a trip of 350 km. How many liters of fuel will you need?

Homework Task 4:

- If 1 kg of apples costs 5 zł, how much will you pay for 3.5 kg of apples?
- If you paid 15 zł, how many kilograms of apples did you buy?

Attachment No. 1 – Debunking Myths About Composting

"Composting Smells Bad"

A properly managed compost bin does not emit unpleasant odors. The key is maintaining a balance between "green" materials (rich in nitrogen, like vegetable peels) and "brown" materials (rich in carbon, like leaves, paper, or sawdust). Unpleasant smells usually occur when there is too much "green" material in the compost or when it is too wet and lacks aeration.

"Composting Is Only for People with Gardens"

Composting doesn't require a lot of space. A small container is enough, which can be placed in the kitchen, on a balcony, or in another area of the home. There are also special composters designed for indoor use, such as bokashi bins or vermicomposters (with worms).

"Composting Requires a Lot of Time and Effort"

Composting is a process that largely "happens on its own." All that's needed is to prepare the right layers of materials, maintain proper moisture, and occasionally turn the compost. The "hard work" is done by microorganisms and worms.

"Composting in an Apartment Attracts Insects and Rodents"

A properly designed compost bin is enclosed and well-ventilated, minimizing the risk of attracting insects or rodents. It's also crucial not to add meat scraps, dairy, or fats to the compost, as these can attract pests.

"Composting Requires Expensive Equipment"

A compost bin can be made from items you already have at home—such as a plastic container, bucket, old basket, or even a cardboard box, as we'll demonstrate during today's workshop! Ventilation holes can be made easily, and compost layers can be created using organic waste that would otherwise be thrown away.

"Composting Requires Specialized Knowledge"

The basic principles of composting are very simple and intuitive. You just need to remember the proper proportions of "green" and "brown" materials, regular aeration, and avoid materials that don't break down easily (e.g., plastics).

"Composting Can Only Be Done in the Summer"

Composting can be done year-round, even in winter. The decomposition process may slow down in colder conditions, but in an apartment, the temperature is usually stable, allowing for year-round composting. Additionally, during winter, you can prepare "brown" materials to balance out "green" waste.

"Anything Organic Can Be Thrown into Compost"

Not all organic materials are suitable for composting. For example:

- NOT Suitable for Composting: meat scrap, fats, dairy products, bones, excess citrus peels (due to acidity).
- YES: Vegetable peels, coffee grounds, eggshells, dry leaves, uncolored paper, cardboard.

Composting requires some waste sorting, but it is also a great way to learn conscious waste management.

Attachment No. 2 – Why Is Composting Worthwhile?

Composting is not only a process of turning organic waste into valuable fertilizer but also a practice that brings numerous benefits to our lives, both ecological and practical. Below are some examples of how composting impacts our lives, the environment, and daily activities

1. Introducing principles of ecology and sustainable development into your life

Composting is a practical step toward an eco-friendly lifestyle:

- Through composting, we learn how nature transforms organic waste into valuable resources. In practice, composting is an inspiring example of closing the loop of materials in nature (understanding the natural cycle).
- Instead of thoughtlessly discarding waste, we start to sort it consciously. Composting promotes the idea of "zero waste," reducing the amount of trash sent to landfills (conscious waste management).
- Rather than generating more waste and relying on artificial fertilizers, we make use of what we already have. Composting supports the practical application of the "reuse" principle in the spirit of sustainable development (resource conservation).

2. Reducing Waste

Not everyone knows that up to 30% of the waste from our kitchens consists of materials suitable for composting! Thus, composting significantly reduces the amount of waste that ends up in the trash, meaning less frequent garbage disposal, fewer garbage bags used, and a cleaner environment.

Additionally, organic scraps discarded in landfills decompose under anaerobic conditions, leading to the emission of methane—a potent greenhouse gas. Home composting eliminates this problem.

3. Creating Free and Natural Fertilizer

Composting allows us to transform kitchen and garden scraps into a valuable product with many uses:

- Compost enriches soil with nutrients, improves its structure, and enhances its water retention capacity. Soil mixed with compost becomes more fertile and resistant to erosion (improving soil quality).

- Instead of buying artificial fertilizers, which can harm the environment and be expensive, we use a free, eco-friendly solution. Compost is chemical-free and plant-friendly (a natural alternative to chemicals).

- Scraps that would normally be considered waste become a valuable resource (reducing resource waste).

4. Supporting the Natural Environment

Composting has both direct and indirect impacts on environmental protection:

- Through composting, we reduce methane emissions from landfills, contributing to the fight against global warming (reducing greenhouse gases).

- The production of artificial fertilizers requires vast amounts of energy and generates carbon dioxide emissions. Composting helps reduce the demand for artificial fertilizers, resulting in lower CO_2 emissions into the atmosphere (decreasing the need for industrial fertilizers).

- Compost supports soil life—microorganisms, earthworms, and other organisms benefit from it, leading to increased biodiversity in our gardens (protecting biological diversity).

5. Saving Money

Composting not only benefits the environment but also provides tangible financial advantages:

- In some areas, reducing waste can lower garbage collection fees (lower waste disposal costs).

- Homemade compost replaces expensive plant care products. Natural fertilizer from compost is just as effective, and often even better, than artificial alternatives (savings on fertilizers).

- Plants grown in soil enriched with compost are healthier, more resistant to diseases, and grow better (more efficient crops).

6. Education and Satisfaction

Composting is also a source of personal satisfaction and learning:

- Observing how waste transforms into fertile humus is a way to connect with nature, even in an urban environment (observing natural processes).

- Composting is a simple action that brings tangible benefits. In times when environmental issues can feel overwhelming, every compost bin is a personal contribution to protecting the planet (sense of agency).

- Composting is a great topic for conversation and education—you can teach children, grandchildren, and friends how to make the world a better place in a simple way (engaging others).

7. Aesthetics and Health of Potted Plants

For people living in apartment buildings, composting can also offer practical benefits for caring for potted plants:

- Compost is an ideal fertilizer for indoor flowers and herbs. It helps plants grow better and develop more beautiful foliage (healthier plants).

- Natural fertilizer eliminates the need for artificial products, which can be harmful to health or the environment (reduced need for chemical treatments).

Attachment No. 3 – Proportions in Composting

Why Are Proportions Important?

Proportions are the foundation of effective composting. The correct ratio of nitrogen-rich ("green") materials to carbon-rich ("brown") materials ensures:

- Efficient waste decomposition – Microorganisms that transform waste into compost require both energy (carbon) and protein (nitrogen).
- No unpleasant odors – Proper proportions prevent rotting and the formation of ammonia.
- Optimal structure – Well-balanced ingredients ensure the compost is neither too wet nor too dry.
-

"Green" materials (rich in nitrogen) include:

- Vegetable scraps.
- Fruit peels.
- Coffee and tea grounds.

Why are they important?
"Green" materials are a source of nitrogen, which supports the growth of microorganisms responsible for the decomposition process.

"Brown" materials (rich in carbon) include:

- Dry leaves
- Cardboard and paperboard (clean, unprinted)
- Paper (e.g., paper towels, newspapers without dyes)
- Sawdust and wood shavings (from untreated wood)

Why are they important?
"Brown" materials provide carbon, which is a source of energy for microorganisms and helps stabilize the composting process

What Happens When Proportions Are Incorrect?

Too much "green" material (nitrogen):

- The compost becomes wet, sticky, and heavy.
- Lack of proper aeration can lead to unpleasant odors, such as the smell of ammonia.
- Microorganisms have an excess of nitrogen and cannot work effectively.

Too much "brown" material (carbon):

- The decomposition process slows down significantly.
- The compost becomes dry and difficult to process.
- Microorganisms lack enough nitrogen to produce the protein needed for growth.

Ideal Proportion:

The carbon-to-nitrogen ratio in compost should be approximately 25:1 to 30:1.

What does this mean in practice?
For every part of "green" materials (e.g., vegetable peels), add 2–3 parts of "brown" materials (e.g., dry leaves, cardboard).

This ensures the compost has the right moisture and aeration, enabling fast and efficient decomposition of waste.

Summary:

Maintaining the correct balance between "green" and "brown" materials is essential to ensure that compost:

Does not smell bad.

Decomposes at an optimal rate.

Becomes a valuable, fertile fertilizer for plants.

Experiment with different materials, but always remember this rule: the balance between "green" and "brown" is the key to success!

Attachment No. 4 – Proportions in Everyday Life

1. Cooking and Recipes

Imagine a recipe is designed for 4 people, but we are cooking for 2 people. We can reduce the proportions by half.

Example:
A cake recipe requires:

- 200 g of flour
- 100 g of sugar
- 2 eggs

For 2 people, we need:

$200/4 = x/2$

$200 \cdot 2 = x \cdot 4$

$400 = 4x$

$x =$ 100grams of flour

$100/4 = x/2$

$100 \cdot 2 = x \cdot 4$

…………………………..

………………………….. 50grams of sugar

$2/4 = x/2$

…………………………..

………………………….. eggs

2. Household Budget Planning

If we spend a certain amount on food per week, we can calculate how much we will spend in a month, assuming similar weekly expenses.

Example: You spend 200 zł per week on food. How much will this be monthly? Assume a month has 30 days.

A week has 7 days, so the monthly spending can be calculated by finding how many weeks are in 30 days:

$200/7 = x/30$

$200 \cdot 30 = x \cdot 7$

3. Shopping and Price Comparisons

Proportions help us compare the prices of products with different package sizes.

Example:
1 kg of rice costs 8 zł, and a 2.5 kg package costs 20 zł.
Which is cheaper per kilogram?
For the 2.5 kg package:

$20/2.5=8$ zł

Answer: The price is the same, so you choose the larger package for convenience.

4. Medication Dosage

If a doctor prescribes a medication at a dose of 10 mg per kilogram of body weight, we can easily calculate the appropriate dose for a given person.

Example:
If you weigh 70 kg, the medication dose is:

…………………………..

…………………………..

5. On a Trip: Calculating Distance and Fuel

Proportions help calculate how much fuel we need for a longer trip if we know the consumption for a shorter distance.

Example:
A car uses 6 liters of fuel per 100 km. How much fuel will it use for 350 km?

$6/100 = x/350$

…………………………..

…………………………..

Answer: You will need …… liters of fuel.

Examples of Simple Tasks for Group Solution in Summary Exercise:

1. Adjusting Recipe Ingredients for a Larger Group
A salad recipe for 4 people requires:

- 200 g of lettuce
- 100 g of tomatoes
- 50 g of feta cheese

How much of each ingredient is needed to make the salad for 10 people?
Hint: Use a proportion to increase the ingredients proportionally to the number of guests.

2. Calculating Trip Costs

A car uses 6 liters of fuel per 100 km, and the price of fuel is 7 zł per liter.
You have planned a route of 250 km.

Question: How much will you pay for fuel for the entire trip?

3. Comparing Unit Prices of Products in a Store

There are two packages of rice available in the store:

- A 1 kg package costs 9 zł.
- A 2.5 kg package costs 21 zł.

Question: Which package is more cost-effective, meaning it has a lower price per kilogram?

Attachment No. 5 – Proportions in Effective Composting – Practice

Task 1: Proportions in Compost (Simple Proportion)

In a home compost bin, we need a ratio of 3:1 (3 parts "brown" to 1 part "green").
The group collected:

6 kg of vegetable peels ("green" materials).

Question: How many kilograms of "brown" materials should be added to maintain the correct proportion?

Task 2: Proportions in Compost (Mixed Materials)

The compost bin requires a ratio of 30:1 (carbon to nitrogen). Below are the carbon-to-nitrogen ratios for the available materials:

Dry leaves: Carbon ratio = 60:1

Sawdust: Carbon ratio = 500:1

Vegetable peels: Carbon ratio = 15:1

The group wants to prepare a mixture that meets the 30:1 carbon to nitrogen ratio.

Question:
How much dry leaves and vegetable peels should be mixed (by weight) to achieve the correct 30:1 ratio?

Task 3: Calculating Percentages in Compost

In your compost bin, you have:

10 kg of "brown" materials

5 kg of "green" materials

Question 1:
What percentage of the compost is made up of "green" materials?

Question 2:
If we want the "green" materials to make up 40% of the total, how much more "green" material should we add?

Task 4: Percentage Content of Ingredients in Fertilizer

The finished compost contains the following nutrient percentages:

Nitrogen (N): 2%

Phosphorus (P): 1%

Potassium (K): 3%

The group is preparing 50 kg of fertilizer from this compost.

Question: How many kilograms of each nutrient (N, P, K) are in the prepared fertilizer?

Task 5: Compost Bin for Multiple Families (Proportions in Practice)

Four families want to set up a shared compost bin. Each family produces different amounts of organic waste:

Family A: 5 kg of "green" waste weekly

Family B: 7 kg of "green" waste weekly

Family C: 3 kg of "green" waste weekly

Family D: 6 kg of "green" waste weekly

Question: What is the total amount of "green" waste produced by all four families per week?

In order for the compost bin to function properly, the ratio of "brown" materials to "green" materials should be 3:1.

Question: How many kilograms of "brown" materials should these families collectively gather per week to maintain the correct ratio?

Attachment No. 6 – Proportions in Everyday Life – Practice

1. **Cooking for a Larger Number of People**

A soup recipe requires:

- 1 liter of water
- 200 g of carrots
- 50 g of onions

The recipe is for 2 people. How much of each ingredient is needed to make the soup for 6 people?

2. Travel Costs

A car uses 8 liters of fuel per 100 km. How much fuel will you need to drive 250 km?

3. Shopping by Weight

In the store, 1 kg of apples costs 6 zł. How much will you pay for 2.5 kg of apples?

4. Composting in an Apartment

Your compost bin requires a ratio of 3:1 (3 parts "brown" to 1 part "green").

You have 4 kg of vegetable peels ("green"). How much "brown" material (e.g., dry leaves) should you add to maintain the correct ratio?

5. Percentages in Compost

Your compost bin contains:

12 kg of "brown" materials

3 kg of "green" materials

Question 1: What percentage of the total is made up of "green" materials?
Question 2: How many kilograms of "brown" materials need to be added for the "green" materials to make up 20% of the total?

6. Comparing Prices in the Store

Compare two offers:

A 1 kg package of rice costs 12 zł.

A 2.5 kg package of rice costs 28 zł.

Question: Which package is more cost-effective (cheaper per kilogram)?

7. Medication Dosage

The medication should be given at a dose of 10 mg per kilogram of body weight. The person weighs 70 kg.

Question: How many milligrams of medication should they take?

8. Diluting a Cleaning Agent

The cleaning agent should be diluted in a ratio of 1:9 (1 part of the agent to 9 parts of water). You have 1 liter of water.

Question: How much cleaning agent should you add to achieve the correct dilution?

Attachment No. 7 – Instructions for Preparing Your Own Home Compost Bin

The compost bin you will create is intended for indoor use, such as in apartments. Its features include simplicity, low cost, and the possibility of using recycled materials. With proper sealing, the compost bin will be odorless and safe to use.

Preparing the Container

- Take a paint bucket with a minimum capacity of 10 liters. The bucket should have a lid. If it is dirty, wash it thoroughly with water and detergent, then dry it.

- On the outside of the bucket, use a marker to draw the spots for the ventilation holes:

• On the sides – 6 holes evenly spaced at half the height of the bucket.

• On the bottom – several small holes to drain excess liquids.

• On the lid – a few small holes for air circulation..

Creating Holes

Using a drill (or another tool), drill the holes:

• On the sides – with a diameter of about 5 mm.

• On the bottom – smaller holes, with a diameter of about 2–3 mm, to allow liquid drainage but prevent materials from spilling out.

• On the lid – also with a diameter of 2–3 mm.

Note: The holes must be smooth to avoid sharp edges. If the edges are rough, smooth them with sandpaper or a file.

Securing the Holes

- Attach a mesh (e.g., with small openings) to the inside of the bucket over all the holes:

- This will prevent the compost from spilling out and keep insects from entering.

- Use adhesive tape to securely attach the mesh to the inside of the bucket.

For the lid, on the inside, attach an odor filter (e.g., made of activated carbon). It can be glued or secured with mesh and tape.

Creating Layers on the Bottom

Prepare a starting layer that will absorb excess moisture – place a layer of dry material (e.g., shredded cardboard, newspaper, or dry leaves) about 5 cm high at the bottom.

This will absorb excess liquids, ensuring the compost bin functions properly.

Compost Bin Usage Instructions

- Adding Waste:

- Alternate adding "green" materials (peels, coffee grounds, vegetable scraps) and "brown" materials (dry leaves, cardboard, paper) in a 3:1 ratio (3 parts brown to 1 part green).

- After each addition, cover the materials with a layer of "brown" – this will help prevent odors.

- Aeration:

- Once a week, gently mix the compost with a shovel or similar tool to ensure proper air circulation.

- Drainage of Liquids:

- If excess liquid accumulates, pour it out through the bottom holes. You can place a tray or plate under the bucket to protect the floor.

- Decomposition Time:

- The compost will be ready for use after about 2–3 months, depending on the conditions and the materials added.

Attachment No. 8 – List of Compostable Waste

1. Kitchen Waste (Green, Nitrogen-Rich):

- Vegetable and fruit peels.
- Vegetable and fruit scraps (e.g., overripe fruit, pumpkin seeds, husks).
- Coffee and tea grounds (including tea bags, if not plastic).
- Crushed eggshells.
- Fresh herb scraps.
- Nut shells (without salt or additives).
- Small amounts of stale bread.

2. Garden Waste (Brown, Carbon-Rich):

- Dry leaves.
- Twigs (broken into smaller pieces).
- Grass (in small amounts, to prevent clumping and rotting).
- Straw and hay.
- Cut flowers (without chemical preservatives).
- Pine needles (in small amounts, due to acidity).
- Hedge and shrub clippings (shredded).

3. Paper and Cardboard Materials (Brown):

- Unprinted cardboard (e.g., egg cartons, cardboard boxes).
- Unglazed paper (e.g., newspapers, paper towels; receipts should not be composted!).
- Paper bags.

4. Other Organic Waste:

- Hair and pet fur.
- Feathers.
- Cotton and linen fabric scraps (clean, without paint).
- Ashes from the fireplace (only wood ash, in small amounts).
- Sawdust and wood shavings (from untreated wood).

What NOT to Compost:

- Meat, fish, and dairy scraps (they can attract pests and produce unpleasant odors).
- Fats and oils.
- Food scraps with spices (especially salt).
- Excess citrus peels (acidity slows down composting).
- Weed seeds and diseased plants (they may spread).
- Plastic bags and synthetic materials.
- Paper coated with plastic or paint.

Tip: Maintain the right balance between "green" (wet, nitrogen-rich) and "brown" (dry, carbon-rich) materials to ensure the composting process runs smoothly!

Scenario No. 9
"Do you know how quickly it gets hot?"

Workshop Objective:

- Introducing participants to the issue of climate change – with a particular focus on global warming, its causes, and its effects on society and the environment.
- Raising awareness about the impact of human activity on the climate – analyzing statistical data on temperatures in Poland and Germany, drawing conclusions, and engaging in discussion.
- Developing mathematical skills – calculating basic statistical parameters such as arithmetic mean, mode, median, and standard deviation.
- Improving participants' arithmetic skills – applying percentages and weighted averages in practical tasks related to temperature changes.
- Developing data interpretation skills – analyzing results and visually presenting them through graphs and charts.

Duration: 3 hours.

Required Materials:

- Whiteboards and markers for recording group task results and calculations.
- Calculators for each participant to perform more complex calculations.
- Attachment No. 1: Basic Statistical Parameters
- Attachment No. 2: Calculating the Arithmetic Mean of Temperatures in Poland and Germany
- Attachment No. 3: Mode and Median – Analyzing Data on Days with Precipitation in a Month
- Attachment No. 4: Calculating the Standard Deviation for Temperatures in Different Regions
- Attachment No. 5: Analyzing the Weighted Average for Different Sources of CO_2 Emissions
- Attachment No. 6: Weighted Average and the Effectiveness of CO_2 Reduction Measures
- Attachment No. 7: Why Use Statistical Measurements in Assessing Temperature Changes?

Workshop Plan:

1. Introduction to the Workshop Topic (20 minutes)

Discussion "Climate Change and Global Warming" – Climate change is one of the greatest challenges of our time, affecting ecosystems, societies, and the global economy. The rise in global temperatures, driven by human activity, particularly the emission of greenhouse gases, leads to serious, multidimensional consequences.

What climate changes are observed in Poland and Germany?

Poland:

- The average temperature in Poland has increased by approximately 1.7°C since pre-industrial times.
- The frequency of heatwaves has tripled over the last 50 years.
- The number of days with temperatures below 0°C has decreased by 15–20 days per year.
- Droughts during the spring and summer months are becoming more frequent and intense, which has an impact on agriculture.

Germany:

- The average temperature has increased by approximately 2°C compared to the 19th century.
- Groundwater levels are decreasing, and regions such as Brandenburg are becoming increasingly dry.
- Extreme rainfall events cause floods, such as the disaster in the Ahr region in 2021.

What effects of climate change do you see in daily life? Is the rise in temperature noticeable to you?
How are the seasons changing?

- Extended summer: In Poland, summer lasts on average 4 weeks longer than it did 50 years ago.
- Warmer winters: In winter, rain is increasingly replacing snow, especially in lowland areas.

Disruption of natural cycles:

- Flowers bloom earlier, which can disrupt ecosystems, such as the synchronization of pollinators with plants.
- Bird migrations are shifting by a few weeks, which can affect the populations of other species.

What does a 1°C increase in average temperature mean for ecosystems?

- Melting glaciers and rising sea levels – Since 1993, sea levels have been rising by 3.3 mm per year. A 1°C increase in average temperature accelerates this process, threatening to submerge low-lying areas (e.g., Bangladesh, the Maldives).

- Ocean acidification – Higher temperatures increase the concentration of CO_2 in oceans, leading to acidification. This, in turn, threatens marine ecosystems, such as coral reefs.

- Loss of biodiversity – A 1°C rise could lead to the extinction of 10% of plant and animal species on Earth.

What does a 1°C increase in average temperature mean for humans?

- Public health – Extreme heat increases the risk of heat strokes and cardiovascular diseases, as well as the spread of tropical diseases, such as malaria, to new areas, including Europe.

- Agriculture – Reduced crop yields due to droughts and disruptions in growing cycles (e.g., cereal production in Poland could decrease by 10–20% in the coming decades).

- Natural disasters – An increase in the number and intensity of hurricanes, floods, and forest fires (the economic costs of such events in Germany in 2021 amounted to approximately 43 billion euros).

After a brief introduction, the facilitator presents the objectives of the workshop to the group – gaining knowledge about climate change (global warming), while simultaneously learning the basics of statistical parameters and their interpretation.

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Introduction to Statistics (30 minutes)

The facilitator, based on Attachment No. 1 (Basic Statistical Parameters), discusses the definition and interpretation of selected statistical parameters:

- Arithmetic mean ("the sum of values divided by their count”).
- Mode ("the most frequent value in the dataset”).
- Median ("the middle value in an ordered dataset”).
- Standard deviation ("a measure of the spread of data around the mean").

For each parameter, the facilitator provides tasks that explain the definition using examples related to temperature. Each example is written on the board and its interpretation is discussed with the group.

2.2. Calculating the Arithmetic Mean of Temperatures in Poland and Germany – Group Work (20 minutes)

Participants receive data on the average annual temperatures in Poland and Germany over the last 10 years (Attachment No. 2 – Calculating the Arithmetic Mean of Temperatures in Poland and Germany).
The task is to calculate the arithmetic mean for each country and compare the results.
As a result, participants will see the differences in average temperatures between the two countries.

2.3. Mode and Median – Analyzing Data on Days with Precipitation in a Month – Individual Work (20 minutes)

Participants analyze the number of days with precipitation in a month, find the most frequent value (mode), and the middle value in the ordered dataset (median) – working with Attachment No. 3 (Mode and Median – Analyzing Data on Days with Precipitation in a Month).
Through this exercise, participants will learn how to interpret precipitation data, identifying the differences between the mode and median.

2.4. Calculating the Standard Deviation for Temperatures in Regions – Group Work (20 minutes)

Seniors receive data on daily temperatures from one month in different provinces of Poland (Attachment No. 4). They calculate the average temperature, the differences from the obtained average, and then the standard deviation.
As a result, participants will understand how temperature variability differs between regions and learn what standard deviation is.

2.5. Analyzing the Weighted Average for Different Sources of CO_2 Emissions – Group Work (20 minutes)

Participants receive data on CO_2 emissions from various sectors of the economy (e.g., transport, industry, energy) and their share in total emissions. The data is provided in tons of CO_2 and percentages (Attachment No. 5).
The goal of the exercise is to calculate the weighted average of emissions to understand which sectors have the greatest impact on the overall emission levels.

2.6. Weighted Average and the Effectiveness of CO_2 Reduction Measures – Individual Work (20 minutes)

Participants, working with Attachment No. 6 (Weighted Average and the Effectiveness of CO_2 Reduction Measures), analyze how the weighted average can be used to assess the effectiveness of CO_2 emissions reduction measures in different sectors, such as transport, energy, and industry. Based on data on emissions before and after implementing reductions and the sectors' shares in total emissions, they calculate the weighted average of CO_2 emissions. They then compare the results before and after the reductions to assess which sectors had the greatest impact on the overall improvement.

2.7. Why Use Statistical Measurements in Temperature Assessment? – Group Discussion (10 minutes)

A group discussion on why statistical measurements, such as the mean, median, and standard deviation, are crucial in analyzing temperature (Attachment No. 7). Participants will discuss how different parameters can help in understanding long-term climate changes, such as global warming, and why single values, such as record high temperatures, may be insufficient for evaluating trends.

3. Conclusion and Workshop Evaluation (10 minutes)

Objective: Allow participants to reflect on the knowledge gained and gather their opinions about the session.

A brief survey assessing the session – which information was most useful, what they would like to explore further in the future.

Homework (to be completed individually by participants):

Homework 1: In the table below, the daily temperatures in °C for the last week in your city are provided:

[18, 20, 19, 20, 21, 20, 22]

Find the temperature that occurred most frequently (the mode).

Consider: Does the mode accurately represent the overall temperature for this week?

Homework 2:

In the table below, the daily temperatures in °C for your city during the week are provided:

[15, 16, 18, 19, 20, 22, 25]

Calculate the average temperature for the entire week by adding all the values and dividing by the number of values.

Consider: Does the average temperature accurately reflect the weather conditions throughout the week? Why?

Homework 3:

Here are the daily temperatures in °C for your city during the week:

[14, 17, 18, 20, 21, 23, 25]

Arrange the data from lowest to highest temperature (if they are not already sorted).
Find the middle value (median).

Compare the median with the average temperature (calculated in the previous task). Which value better describes the weather conditions this week?

Homework 4:

In the table below, the daily temperatures in °C for two different weeks are provided:

Week 1:

[15, 16, 16, 17, 18, 19, 20]

Week 2:

[10, 15, 16, 22, 25, 28, 30]

Calculate the average temperature for both weeks.

For each week, calculate the difference between each temperature and the average. Then square these differences, add them, and divide by the number of days.

Calculate the square root of the obtained value (standard deviation).

Consider: In which week was the temperature spread greater? What does this mean?

Attachment No. 1 – Basic Statistical Parameters

Arithmetic Mean

Definition:

The arithmetic mean is the sum of all values in a dataset divided by the number of those values.

Simplified Definition:

It is the result when you divide the total sum of the data by the number of values.

Example: Weekly temperatures in Warsaw:

[15, 16, 18, 19, 21, 21, 23] (in °C)

Sum: 15 + 16 + 18 + 19 + 21 + 21 + 23 = 133

Arithmetic mean: 133 / 7 = 19°C

Interpretation: The average temperature for the week is 19°C, which reflects the overall warmth during this period.

Mode

Definition:

The mode is the value that appears most frequently in a dataset.

Simplified Definition:
It is the number that "repeats the most."

Example: Temperatures in Berlin over 7 days:

[15, 16, 16, 19, 19, 19, 22] (in °C)
Mode: 19°C, because it appears 3 times.

Interpretation: The most frequently recorded temperature in Berlin this week was 19°C.

Median

Definition:

The median is the middle value in an ordered dataset (if the number of data points is odd) or the average of the two middle values (if the number of data points is even).

Example: Temperatures in Gdańsk over the week:

[13, 15, 15, 18, 19, 20, 22]

Median: 18°C, because it is the middle value in the dataset.

If the dataset had an even number of elements:

[13, 15, 18, 20]

Median: = (15 + 18)/2 = 16,5°C

Interpretation: The median shows that half of the days were cooler than 18°C and half were warmer (for the first example).

Standard Deviation

Definition:

Standard deviation measures how much the data in a set are spread out around the mean. The larger the standard deviation, the greater the variability of the data.

It is a number that tells us how much the data is "spread out" around the mean.

Example: Weekly temperatures in Warsaw:

[15, 16, 18, 19, 21, 21, 23] (w °C)

Sum: 15+ 16 + 18 + 19 + 21 + 21 + 23 = 133

Arithmetic mean: 133/7 = 19 °C

Differences from the mean:

$(19-15)^2 = 4^2 = 16$

$(19-16)^2 = 3^2 = 9$

$(19-18)^2 = 1^2 = 1$

$(19-19)^2 = 0^2 = 2$

$(19-21)^2 = (-2)^2 = 4$

$(19-21)^2 = (-2)^2 = 4$

$(19-23)^2 = (-4)^2 = 16$

The sum of these differences: 52

Standard deviation: The square root of the sum of the difference divided by the number of measurements, i.e., the square root of 52/7, which is approximately 2.73 °C.

Interpretation: The data are dispersed on average by 2.73°C around the mean, indicating moderate temperature variability.

Examples for discussion with participants:

Arithmetic mean – Changes in the average annual temperature in Poland over the past decades.

Discussion: How could an increase in the average temperature by 1°C affect the environment and society?

Mode – An analysis of which season over the past 20 years had the most days with precipitation. What does this mean for agriculture?

Median – A discussion on why the median is sometimes more representative than the mean. Example: Temperatures with extremes, e.g., [−10, 2, 5, 8, 40].

Standard deviation – An analysis of temperature variability in Warsaw and Berlin. Discussion: Why might variability be greater in one location than in another?

Attachment No. 2 – Calculating the Arithmetic Mean of Temperatures in Poland and Germany

Introduction:

Below are the data on the average annual temperatures in Poland and Germany over the past 10 years. The task for the group is:

- To calculate the arithmetic mean of the temperatures for each country.
- To compare the results and consider what might influence the differences in temperatures between Poland and Germany.

Data:

Average annual temperatures in Poland (°C):

2013: 8,5

2014: 9,2

2015: 8,7

2016: 8,9

2017: 8,6

2018: 9,5

2019: 9,7

2020: 9,3

2021: 9,0

2022: 9,6

Average annual temperatures in Germany (°C):

2013: 9,6

2014: 10,3

2015: 10,0

2016: 9,8

2017: 9,7

2018: 10,5

2019: 10,6

2020: 10,4

2021: 10,1

Instructions for the Group:

- Divide the tasks among the group members:

One person writes down the data on paper.

Another adds up all the values for Poland.

A different person does the same for Germany.

- Finally, calculate the average temperature by dividing the total sum by the number of years (10 years).

- Write down the results on paper:

Average temperature in Poland: ……

Average temperature in Germany: ……

- Compare the results and answer the following questions:

• Which country has a higher average temperature? By how many degrees?

• What factors might contribute to these differences? Consider aspects such as geographical location, proximity to seas, or differences in terrain.

Hints for the Group:

- You can use a calculator to make adding numbers and dividing easier.

- Write down your calculations so they can be reviewed and discussed with the instructor at the end.

Summary Section:

After completing the task, present your group's results.

Discussion:

- What conclusions did you draw from comparing the temperatures in Poland and Germany?

- Are the differences in average temperatures surprising? Why or why not?

Attachment No. 3 – Mode and Median – Data Analysis of Days with Precipitation in a Month

Introduction:

Below are the data on the number of days with precipitation in the summer months (June, July, August) for two regions: Poland and Germany. Participants are tasked with the following:

- Identify the most frequently occurring number of days with precipitation (mode) for each region.
- Determine the middle value in the ordered dataset (median).
- Compare the results and consider what they might indicate about the weather characteristics in each region.

Data:

Poland – Number of Days with Precipitation in Summer Months (2013–2022):

June: 12, 10, 11, 13, 10, 9, 10, 12, 11, 10

July: 14, 15, 13, 12, 14, 15, 14, 14, 13, 12

August: 10, 8, 11, 9, 10, 11, 10, 12, 10, 9

Germany – Number of Days with Precipitation in Summer Months (2013–2022):

June: 13, 12, 11, 14, 13, 12, 12, 12, 11, 13

July: 15, 14, 14, 16, 15, 14, 14, 15, 14, 15

August: 11, 10, 10, 12, 11, 11, 11, 10, 11, 10

Instructions for Participants:

Task 1: Mode

Identify the number of days that appears most frequently (mode) for each month from the data. Write down the results for Poland and Germany.

Reflection Question:

Does the mode accurately reflect the weather in these months? Why or why not?

Task 2: Median

Arrange the data for each month in ascending order, from the smallest to the largest number of days. Identify the middle value (median).

Reflection Question:

Does the median differ from the mode? What additional information does it provide?

Task 3: Comparison

Compare the results of the mode and median between Poland and Germany. Reflect on what the differences in the number of days with precipitation might mean for both countries. Consider climatic differences and terrain features.

Hints for Participants:

Work in groups, dividing the months among yourselves to speed up the task.

Remember:

Mode is the number that occurs most frequently in a given dataset.

Median is the middle value after arranging the data in ascending order.

Attachment No. 4 – Calculating the Standard Deviation for Temperatures in Regions

Introduction:

Below are the data on daily temperatures in January for three Polish provinces: Mazowieckie, Małopolskie, and Pomorskie. Participants are tasked with the following:

- Calculate the average temperature for each province.
- Compare each daily temperature to the calculated average to understand how much individual days deviate from the mean.
- Understand how temperature variability (spread) in different regions affects data interpretation.

Data:

Mazowieckie Province – Daily Temperatures in January (°C):

-2, -3, 0, 1, -1, -2, -4, -3, 0, 2

Małopolskie Province – Daily Temperatures in January (°C):
0, 1, 2, -1, -2, 0, 1, 3, 2, -1

Pomorskie Province – Daily Temperatures in January (°C):

2, 3, 1, 0, -1, 2, 1, 4, 3, 2

Instructions for Participants:

Step 1: Calculate the average temperature for each province.

Add all the temperatures from one province.

Divide the sum by the number of days (10 days).

The result is the average temperature for the given province. Remember the result!

Step 2: Compare each daily temperature to the calculated average.
Answer the following questions:

- Was the temperature on a given day higher or lower than the average?
- By how much did the temperature differ from the average?

Step 3: Reflect on the temperature spread.

How much do the lowest and highest values differ from the average?

Which province has more "stable" temperatures, and which one experiences greater fluctuations?

Step 4: Understand standard deviation.
The facilitator will explain that standard deviation is a measure of how much most days deviate from the average. The larger the standard deviation, the greater the variability in temperatures within a province.

Step 5: Using the definition provided in Attachment No. 1, calculate the standard deviation for each provinc

Reflection Questions:

Comparison of Provinces:

- Which province had the most stable temperatures (smallest deviations from the average)?
- Which province experienced the most variable weather? What significance does this have for its residents?
- The Importance of Standard Deviation:

Why is it valuable to measure the spread of temperatures around the average rather than relying only on the average temperature?

Tips for Participants:

- Work in groups – each group analyzes one province.
- Use calculators to speed up your calculations.
- Write down your results on paper to discuss them with the facilitator.

Attachment No. 5 – Weighted Average Analysis for Different Sources of CO_2 Emissions

Introduction:

The weighted average is a method to evaluate the significance of various sectors in total CO_2 emissions, taking into account their percentage contribution. Each sector (transport, industry, energy) emits a different amount of CO_2 and has a different share in total emissions. The participants' task is to:

- Calculate the weighted average emissions for the economic sector based on percentage shares.
- Compare which sectors have the greatest impact on the overall result.

Data:

Total CO_2 emissions: 1000 million tons

Transport: Emissions: 200 million tons

Industry:

Emissions: 300 million tons

Share: 30%

Energy Sector:

Emissions: 500 million tons

Share: 50%

Instructions for Participants:

Step 1: Understanding the Data

The number of tons of CO_2 represents the emissions for each sector.

The percentage share (e.g., 20%) is the weight, indicating how much of the total emissions is attributed to each sector.

Step 2: Calculating the Weighted Average

To calculate the weighted average, multiply the emissions (in million tons) by the share of each sector (convert percentages to decimal values, e.g., 20% = 0.2).

Step 2: Calculating the Weighted Average

To calculate the weighted average, multiply the emissions (in million tons) by the share of each sector (convert percentages to decimal values, e.g., 20% = 0.2).
Record how much "weighted" emissions each sector contributes:

Transport: 200

$200 \times 0.2 =$……………………………..

Industry: ………………………………

Energy Sector: ………………………………

Step 3: Summing the Results

Add up all the weighted emissions values to obtain the weighted average:

……………………………………………………………

Weighted Average: …………….. million tons of CO_2

Interpretation of Results:

The weighted average is …………….. million tons of CO_2.

The energy sector contributes the most to emissions because it accounts for half of the total emissions.

Transport has the smallest share, even though it emits 200 million tons of CO_2—its impact is lower due to its small percentage share.

- Reflection for Participants:
- Which sector has the greatest impact on total emissions? Why?
- Does the weighted average help better understand the role of each sector in CO_2 emissions?
- What actions could reduce emissions in the sector with the largest share?

Attachment No. 6 – Weighted Average and the Effectiveness of CO_2 Reduction Measures

Introduction:

Below are data on CO_2 emissions from three economic sectors: transport, industry, and energy. The data include emissions before and after implementing reduction measures, as well as the percentage share of each sector in total emissions.

Participants' Tasks:

- Calculate the weighted average emissions before and after reduction.
- Compare the results and identify which sectors had the greatest impact on reducing total CO_2 emissions.
- Reflect on what additional measures could further improve the efficiency of emission reductions.

Data:

Total CO_2 emissions before reduction: 1000 million tons

Reduction in CO_2 emissions by sector (in %):

Sektor	Emisje przed redukcją (mln ton)	Procentowy udział	Procentowa redukcja	Emisje po redukcji (mln ton)
Transport	200	20%	10%	180
Przemysł	300	30%	15%	255
Energetyka	500	50%	20%	400

Instructions for Participants:

Step 1: Analyze Data Before Reduction

Examine the CO_2 emissions for each sector (column "Emissions before reduction") and their percentage share.

Consider which sectors dominate the total emissions.

Step 2: Calculate the Weighted Average Emissions Before Reduction

To calculate the weighted average, take into account the contribution of each sector (percentage share) to the emissions before reduction.

Step 3: Analyze Data After Reduction

Examine the changes in emissions after implementing reduction measures (column "Emissions after reduction").

Which sectors reduced their emissions the most, and which reduced them the least? Why?

Step 4: Calculate the Weighted Average Emissions After Reduction

Take into account the emissions after reduction and the percentage share of each sector.

Step 5: Compare Results

Compare the weighted average emissions before and after reduction.

Calculate the difference: by how much has the weighted average CO_2 emissions decreased?

Conclusions:

Which sector contributed the most to the overall improvement?

Example Analysis: Transport

Before reduction, transport emitted 200 million tons of CO_2, accounting for 20% of total emissions.
After a 10% reduction, transport emissions decreased to 180 million tons of CO_2.
Although transport had the smallest percentage share, the reduction in this sector contributed to the overall decrease in emissions.

Reflection:

- Which sector reduced its emissions the most in absolute numbers? (Energy sector)

- Which sector had the largest percentage contribution to the overall reduction in emissions?

Final Discussion:

- Should the energy sector, having the largest share of emissions, be the priority for further reduction efforts?

- What additional measures could further reduce emissions in the transport or industrial sectors?

Attachment No. 7 – Why Use Statistical Measurements to Assess Temperature Changes?

Introduction to the Discussion:

In the analysis of temperature and climate change, individual values, such as a record-high temperature on a given day, may be interesting but do not reflect the full picture. Statistical measurements, such as the mean, median, or standard deviation, enable a deeper analysis of the data and a better understanding of long-term changes.

During the group discussion, participants will consider:

- What are the benefits of using various statistical measures in temperature analysis?
- Why is it not sufficient to base conclusions about the climate on single extreme values?
- What additional insights can be gained by using several different statistical measures?

Discussion Topics:

Arithmetic Mean – "What does a typical day look like?"

The average temperature provides a general idea of the overall temperature level during a specific period, such as a month or a year.

Questions for the Group:

- Does the mean accurately represent the weather if there were very high and very low temperatures during the week?
- How can the mean help in analyzing long-term trends, such as global warming?

Median – "The middle value – more representative than the mean?"

The median is the middle value in a dataset, and it is not affected by outliers (e.g., extremely high or low temperatures).

Questions for the group:

- Does the median better reflect the temperatures in a month where there was one day of extreme heat?

- When can the median be more useful than the mean?

Standard Deviation – "How variable is the weather?"

Standard deviation shows how much temperatures deviate from the mean – in other words, how stable or variable the weather was.

Questions for the group:

- Why is it important to know the variability of temperatures, rather than just their average?

- What does a larger or smaller standard deviation mean in climate analysis?

Extreme Values – "Records, but is that the full story?"

Temperature records, such as the hottest day of the year, attract attention, but on their own, they are not sufficient for analyzing climate change.

Questions for the group:

- Why does a record temperature on a given day not provide much information about long-term climate trends?

- How can we better understand climate change by using temperature data from the entire year?

Example for group discussion

Situation:

- In city A, the average temperature in July was 25°C, but on one day the temperature rose to 40°C, which was a record.
- In city B, the average temperature was also 25°C, but the temperatures during the month ranged from 23°C to 27°C.

Questions for the group:

- Did these cities have a similar climate in July?
- How would the standard deviation help in understanding the differences between these two cities?
- Why might relying only on records (e.g., 40°C in city A) be misleading?

Summary of the Discussion

Common Conclusions:

- Single values, such as records, can be useful, but they are insufficient for assessing climate trends.
- Statistical measures help capture the full picture of data, enabling the analysis of average conditions, variability, and deviations.

Application in Daily Life

How can seniors use this information, for example, to plan trips or prepare for climate changes?

Scenario No. 10

"Do you know what is more likely in nature?"

Workshop Objective:

- To learn the basic principles of combinatorics, in particular the multiplication rule, as a tool for solving everyday problems of randomness and organisation
- To understand a simplified definition of the calculus of probability, enabling intuitive calculation of the chances of events occurring in everyday life
- Developing calculus skills, including operations on fractions, converting values into percentages and interpreting them in practical situations
- To reinforce logical thinking and mathematical analysis skills by applying the rules of combinatorics and calculus of probability to multi-step tasks
- Demonstrate the practical dimension of mathematics, including its applications in the garden, nature and everyday choices

Duration 3 hours

Required Materials:

- Whiteboards and markers for recording group task results and calculations.
- Calculators for each participant to perform more complex calculations.
- Attachment No. 1: Probability calculus - interesting facts
- Attachment No. 2: Multiplication rule in the garden - 6 practical tasks
- Attachment No. 3: Elementary tasks in probability calculus (one-step event)
- Attachment No. 4: Elementary tasks in probability calculus (multi-stage event)

Workshop Plan:

1. Introduction to the Workshop Topic (20 minutes)

The presenter begins:

'Maths is everywhere - from weather forecasts, to planning in the garden, to the decisions we make every day. But have you ever wondered how mathematics can help us make sense of what seems random, such as when a bee chooses a rose over a tulip?'

Introduction Objective:

To make participants curious and show that mathematics, especially the calculus of probability, has a place in everyday life.

Example of question:

'Which is more likely: that it will rain tomorrow or that a bee will visit a daisy in your garden? These are the kinds of questions we will be tackling today!'

The presenter explains in simple language:

Probability calculus is a branch of mathematics that deals with the study of the chances of different events.

It helps us answer the question: how likely is it that something will happen?

The probability value is always between 0 and 1:

0 means that something is impossible.

Example: Throwing the number 7 on the dice.

- 1 means that something is certain.
- Example: After night comes day.
- Most events have a probability somewhere 'in between', such as a 50% chance of an eagle in a coin toss.

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Introduction to combinatorics - the multiplication rule in the garden (30 minutes)

The trainer introduces the multiplication rule using practical examples:

Task 1: Arranging a flower bed

We have 3 different kinds of flowers in the garden: roses, tulips and lilies. We want to arrange them in a row. In how many different ways can this be done?

Solution:

First place in the flower bed:

We can choose any of the 3 flowers (3 possibilities).

Second place:

That leaves 2 flowers to choose from (2 possibilities).

Third place: 1 flower remains (1 possibility).

Multiplication rule:

Number of possible arrangements = $3 \cdot 2 \cdot 1 = 6$

Answer: Flowers can be arranged in 6 different ways.

Task 2: Flower pots

Content: We have 4 different plants (roses, tulips, lilies, daisies) and we want to plant them in 2 pots (one plant in each). In how many different ways can the plants be selected and planted in the pots, assuming that the order matters (which pot comes first)?

Solution:

First pot:

We can choose any of the 4 plants (4 possibilities).

Second pot: 3 plants remain (3 possibilities).

Multiplication rule:

Number of possible arrangements = $4 \cdot 3 = 12$

Answer: We can plant plants in 12 different arrangements.

Task 3: Garden path

Content: We have 5 different types of stone (basalt, granite, sandstone, limestone, marble) and we want to line them up on a garden path. In how many ways can we arrange them?

Solution:

First place on the path:

We can choose any of the 5 stones (5 possibilities).

Second place: 4 stones remain (4 possibilities).

Third place: 3 stones remain (3 possibilities).

Fourth place: 2 stones remain (2 possibilities).

Fifth place: 1 stone remains (1 possibility).

Multiplication rule:

Number of possible hands = $5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$

Answer: The stones can be arranged in 120 different ways.

Task 4: Planting plants in rows

Content: In the garden we want to plant 6 different plants in 3 rows, 2 plants in each row. In how many ways can plants be chosen for the first row if the order in the row matters?

Solution:

First plant to the first row:

We can choose any of the 6 plants (6 possibilities).

Second plant to the first row:

5 plants remain (5 possibilities).

Multiplication rule:

Number of possible arrangements in the first row

$= 6 \cdot 5 = 30$

Answer: There are 30 different ways to choose plants for the first row.

Task 5: Deploying bee hives

Content: We have 4 different types of hives (wooden, clay, plastic, straw) and we want to position them along the garden path. In how many ways can they be positioned?

Solution:

First place: We can choose any of the 4 hives (4 possibilities).

Second place: That leaves 3 hives (3 possibilities).

Third place: That leaves 2 hives (2 possibilities).

Fourth place: 1 hive remains (1 possibility).

Multiplication rule:

Number of possible arrangements = $4 \cdot 3 \cdot 2 \cdot 1 = 24$

Answer: The hives can be arranged in 24 different ways.

Task 6: Planting trees in the garden

Content: In the garden we have 3 different species of trees (apple tree, pear tree, plum tree). We want to plant them in a line, but the apple tree always has to be at the end. In how many ways can these trees be planted?

Solution:

The apple tree is fixed in last place (1 possibility).

The other 2 trees (pear, plum) can be set in any order:

Number of permutations for 2 trees: $2 \cdot 1 = 2$

Multiplication rule:

Number of possible arrangements = $1 \cdot 2 = 2$

Answer: The trees can be planted in 2 different ways.

The trainer can explain at this point what permutations are, but can also avoid the concept (say ‘first place: 2 trees remain second place: 1 tree remains’ and use the multiplication rule).

2.2. The multiplication rule in the garden - practical individual exercise (30 minutes)

Participants work independently with Appendix 2 (Multiplication rule in the garden - 6 practical tasks). They solve simple calculus tasks by analogy with those introduced by the trainer - the multiplication rule.

Task 1: You have 4 different pots (wooden, ceramic, plastic, clay). You want to line them up on the terrace. In how many different ways can you do this?

Task 2: You have 3 different kinds of plants in your garden (roses, tulips, lilies). You want to plant them in a row. In how many different ways can you arrange them?

Task 3: You have 5 different kinds of flowers and you want to arrange them in a 3-flower composition in a pot, the order in the pot being important. In how many ways can you do this?

Task 4: You want to arrange 4 different decorative stones (basalt, granite, marble, limestone) in any order on the path. In how many ways can they be arranged?

Task 5: You have 3 different types of beehives (wooden, straw, clay) and you want to position them along the garden. In how many ways can you do this?

Task 6: You want to hang 4 different ornaments (bells, lanterns, a flowerbed, a sign) on the fence. How many ways can you hang them if each ornament is to have its own unique place?

Participants have about 15 minutes to solve the examples, after which time the results are given on the board. Participants can use simple calculators. In addition, it is the workshop participants' task to draw out the possibilities for Task 2 and Task 5.

2.3. Theoretical introduction to the calculus of probability - simply and practically (20 min)

The facilitator provides the group with an intuitive definition of probability - Probability is a way of assessing how likely it is that an event will happen. We can think of it as a measure of the chance of something happening when we are not completely sure of the outcome.

Through probability, we can better understand a world full of random events and plan our actions by anticipating different possibilities.

What does 'event' mean in probability calculus?

Imagine situations that may happen, but the outcome is not known in advance. We call each such possible event a random event. For example:

- If you flip a coin, the random events are 'eagle' or 'heads'.
- If you plant a seed, the random events are 'will germinate' or 'will not germinate'.
- If the weather forecast says possible rain, the random events are 'it will rain' or 'it will not rain'.

Probability - a measure of chance

Probability tells us how likely an event is to occur. It is expressed by a number that is always between 0 and 1:

- 0 means an impossible event - something that is certain not to happen (e.g. throwing the number 7 on a standard dice).
- 1 represents a definite event - something that is certain to happen (e.g. night will be followed by day).
- Numbers between 0 and 1 (e.g. 0.5 or 0.75) denote different levels of probability. The closer to 1, the greater the chance that the event will occur.

How do we calculate probability?

To calculate probability, we need to know:

- How many possible events there are in a given situation.
- How many of these events favour what we want to predict.

We use a simple formula:

Probability of a given event =

number of favourable events / number of all possible events

Explanatory example:

You have 4 different flowers: a rose, a tulip, a lily and a daisy. If a bee randomly chooses one of them, what is the probability that it will choose the rose?

Number of all possible events: 4 (because the bee can choose a rose, a tulip, a lily or a daisy).

Number of favourable events (choosing a rose): 1.

Calculation:

P(rose) = ¼

How can we express probability?

- As a simple fraction: ¼
- As a decimal number: 0.25
- As a percentage: 25%

We choose the way of expression that is easiest for us or the one imposed on us by the task!

Why is probability important?

- It helps us understand a world full of randomness, e.g. the weather, plant growth or animal decisions.
- It enables us to plan better, e.g. watering the garden, planting seeds or choosing when to go for a walk.
- Helps to make informed decisions in everyday situations.

Examples from everyday life:

Flipping a coin: The probability of throwing an eagle is 1/2, because there are two possible outcomes.

Weather forecast: If the forecast says there is a 70% chance of rain, this means the probability P

(rain) = 0.7.

Choice of pot: You have 5 pots, 1 of which is ceramic. The chance of choosing a ceramic one is ⅕ or 20%.

Seed germination: Out of 10 seeds, 7 usually germinate. The probability of germination is 7

10 = 70%.

Dice throw: If you throw a dice and want to throw a 4, the chance is ⅙.

2.4. Elementary tasks in probability calculus (one-step event) - group work (30 min)

The seniors then solve 10 practical tasks in the form of group work, in which they calculate the probabilities of the given events happening - groups work with Appendix 3.

Task 1: There are 4 flowers in the garden: a rose, a tulip, a lily and a sunflower. If a bee randomly chooses one flower, what is the probability that it will choose the rose?

Task 2: The weather forecast says that rain can only fall on one of the days of the week. What is the probability that it will rain on Monday?

Task 3: There are 3 bees and 1 butterfly in the garden. If you randomly select one insect, what is the probability that it will be a bee?

Task 4: There are 3 pots in the garden shed: red, green and blue. What is the probability that you will choose the green pot?

Task 5: There are 4 birds sitting on a tree: 2 sparrows and 2 pigeons. What is the probability that the first bird to fly away will be a sparrow?

Task 6: In a packet of seeds you have 8 flower seeds: 5 roses and 3 tulips. What is the probability that a randomly selected seed is a tulip seed?

Task 7: You have 5 decorative stones of different colours: white, black, grey, red and yellow. What is the probability that a randomly selected stone will be red?

Problem 8: You have 6 fruits in your basket: 3 apples, 2 pears and 1 plum. What is the probability that a randomly selected fruit is an apple?

Task 9: There are 4 pots in the garden, each with one flower: 1 rose, 1 tulip, 1 lily, 1 daisy. What is the probability that a randomly selected pot contains a lily?

Task 10: There are 7 flowers blooming in the garden: 3 are red, 2 yellow, 1 white and 1 blue. What is the probability that a randomly selected flower will be red?

The groups are given a quarter of an hour to solve the tasks, after which time they present their results to the board - they give the results as simple fractions, decimals or percentages.

2.5. Elementary tasks in probability calculus (multi-stage event) - group work (30 min)

Groups work with Appendix 4 (8 tasks in probability calculus - multi-stage events in the garden).

They solve simple examples calculating the probability of consecutive events.

Task 1: There are 4 flowers in the garden: a rose, a tulip, a lily and a daisy. A bee visits two of the flowers, one after the other. What is the probability that it visits the rose first and then the tulip?

Task 2: You have 3 different species of plants in your garden: roses, tulips and lilies. When planting them in two pots, you choose the order randomly. What is the probability that you will plant a tulip in the first pot and a rose in the second pot?

Task 3: You have 4 pots: red, green, blue and yellow. You randomly choose two pots to plant flowers in. What is the probability that the first pot you choose will be red and the second pot green?

Task 4: There are 3 birds in the garden: a sparrow, a titmouse and a starling. One bird sits on an apple tree and the other on a pear tree. What is the probability that the sparrow sits on the apple tree and the titmouse sits on the pear tree?

Task 5: There are 5 stones on the path: white, black, grey, red and yellow. You randomly choose two stones, one by one. What is the probability that you will choose the white stone and then the black stone?

Task 6: You have 3 different plants: roses, tulips and lilies. You plan to water them in a random order. What is the probability that you will water the roses first and then the lilies?

Task 7: There are 4 fish swimming in a pond: 2 carp, 1 carp and 1 goldfish. You randomly catch two fish, one after the other. What is the probability that you catch the carp first and then the goldfish?

Task 8: You have 3 types of flowers in your garden: roses, lilies and tulips. You choose two flowers for a bouquet, one after the other. What is the probability that you will choose the lily first and then the rose?

Warning:

Events are disjoint (mutually exclusive) if they cannot occur simultaneously. For disjoint events, we apply the rule of addition, not multiplication.

Example: There are two types of seeds in the garden: flower seeds (60%) and vegetable seeds (40%). The probability that we draw either a flower seed or a vegetable seed (these events are disjoint) is: 0,6+0,4 = 1.

The presenter conclude - the multiplication rule works when:

- We want to calculate the probability of several events occurring simultaneously or in a particular order.
- We take into account whether the events are dependent or independent (explains the concept of event dependence).
- Events are not disjoint, because disjoint events require the addition rule, not the multiplication rule.

3. Conclusion and evaluation of the workshop (10 minutes)

Aim: To enable participants to reflect on what they have learnt and to gather their feedback on the activities.

Brief evaluation questionnaire of the class - what information was most useful, what they would like to develop in the future.

Homework tasks (to be completed by participants themselves):

Homework task 1: There are 6 flowers growing in the garden: 3 roses, 2 tulips and 1 lily. If a bee randomly chooses one flower, what is the probability that it will choose a rose?

Homework task 2: There are 10 seeds in a packet of seeds: 6 are flower seeds and 4 are vegetable seeds. What is the probability that a randomly selected seed is a vegetable seed?

Homework task 3: You have 4 pots: one green, one blue, one red and one yellow. If you randomly select one pot, what is the probability that you will select the red pot?

Homework task 4: There are 5 birds sitting on an apple tree in the garden: 2 sparrows, 2 starlings and 1 titmouse. If you choose one bird to observe, what is the probability that it will be a tit?

Homework task 5: There are 7 decorative stones lying on the path: 3 are white, 2 are black and 2 are grey. What is the probability that a randomly selected stone will be white?

Attachment No. 1: Probability calculus - interesting facts

Lottery

'The chance of winning the top prize in Lotto is 1 in 13,983,816. This means that the probability of hitting a six is like finding one needle in 14 million haystacks!'

Aircraft and safety:

'The probability of an aircraft accident is 1 in 11 million. By comparison, the probability of being struck by lightning in a year is 1 in 1 million!'

Coin toss:

'If you flip a coin 10 times, the chance that all the tosses will produce an eagle is 1 in 1024. Surprising, isn't it?'

Nature and probability

Two rainbows:

'The chance of seeing a double rainbow is less than 1 in 10, but when it's raining and the sun is shining, it's worth looking around the sky!'

Bees and flowers:

'A bee visits an average of 50-100 flowers in one day. But if it were to pick flowers at random from a meadow full of 1,000 flowers, the chance of visiting a particular flower is 1 in 1,000.'

Mathematical surprises

Dice:

'The probability of throwing two sixes in a single throw of two dice is 1/36. But for many people it seems that the chance is higher!'

Dice throw vs number of eyes:

'If you throw two dice, the most likely result will be a mesh total of 7. Why? Because there are as many as 6 ways to get it, e.g. (1+6), (2+5), (3+4).'

Surprising facts of life

Trains vs delays:

‘If train delays happen 1 in 5 times, and you commute by train every day, the chance that at least one train a week will be late is as high as 67%! That's why it happens to us so often.’

Queues in the shop:

‘The chance of you standing in the slowest queue in a shop is higher than you think - it's as high as 1 in 3, because we tend to choose randomly without analysing the speed of other checkouts.’

Genetics:

‘If you have a brother or sister, the chance of you having exactly the same set of genes from your parents is 1 in 70 trillion!’

Attachment No. 2: Multiplication rule in the garden - 6 practical tasks

Task 1: Arranging the pots on the terrace

You have 4 different pots: a wooden pot, a ceramic pot, a plastic pot and a clay pot. You want to line them up on the terrace. In how many different ways can you do this?

Tip:

Think about how many pots you can choose for the first place (all are available). Then think about how many pots will be left for the next place once you have chosen one. Repeat this process until each pot has found its place.

Task 2: Planting plants in a row

You have 3 different species of plants in your garden: roses, tulips and lilies. You want to plant them in a row. In how many different ways can you arrange them?

Tip:

First choose which plant you want to plant first. Then choose one of the other two plants for the second place. The last plant will automatically take the third place. Think of all the possible orders.

Task 3: Flower composition in a pot

You have 5 different types of flowers and you want to create a composition of 3 flowers from them. The order in the pot matters. In how many ways can you do this?

Tip:

First choose the flower for the first place in the composition from among all 5. Then choose the flower for the second place from among the others 4. Finally choose the third flower from among the others 3. Think of different possible arrangements.

Task 4: Stones on the path

You have 4 different decorative stones: basalt, granite, marble and limestone. You want to arrange them in any order on the path. In how many ways can they be arranged?

Tip:

Start by choosing the first stone from among all 4. Then choose a stone for the second place from among the remaining 3. Then choose a stone for the third place from among the two that are left. The last stone will automatically take the last place.

Task 5: Beehives in the garden

You have 3 different types of beehives: a wooden beehive, a straw beehive and a clay beehive. You want to place them along the garden. In how many ways can you do this?

Tip:

Start by choosing which hive will stand first. Then choose the second hive from the other two. The last hive will take the third place. Try to imagine the different possible order in which the hives can be placed.

Task 6: Ornaments on the fence

You have 4 different ornaments on your fence: bells, lanterns, a flowerbed and a sign. You want to hang them in different places so that each ornament has its own unique place. How many ways can you do this?

Tip:

First choose what to hang in the first place. Then choose one of the other ornaments for the second place. Then choose a third ornament for the third place. The last ornament will automatically go to the fourth place.

Attachment No. 3: Elementary tasks in probability calculus (one-step event)

Task 1: Bees and flowers

There are 4 flowers in the garden: a rose, a tulip, a lily and a sunflower. If a bee randomly chooses one flower, what is the probability that it will choose the rose?

Hint:

Think about how many possible flowers there are to choose from. Then count how many of them are roses. Divide the number of roses by the number of all flowers to find the probability.

Task 2: Weather forecast

The forecast says that rain can only fall on one of the days of the week. What is the probability that rain will fall on Monday?

Tip:

Start by counting how many days there are in a week. Since rain can fall on one of them, think about the chances that you will choose exactly Monday. Divide the number of days with rain by all the days of the week.

Task 3: Insects in the garden

There are 3 bees and 1 butterfly in the garden. If you randomly choose one insect, what is the probability that it will be a bee?

Hint:

Count all the insects in the garden. Then consider how many of these insects are bees. You will calculate the probability by comparing the number of bees with the total number of insects.

Task 4: Choosing pots

There are 3 pots in the garden shed: a red pot, a green pot and a blue pot. What is the probability that you will choose the green pot?

Tip:

Think about how many pots there are to choose from. Then check how many of them are green. Compare the number of green pots to the total number of pots to find the probability.

Task 5: Birds in a tree

There are 4 birds sitting in a tree: 2 sparrows and 2 pigeons. What is the probability that the first bird to fly away will be a sparrow?

Tip:

Start by counting all the birds in the tree. Then think about how many of them are sparrows. To find the probability, compare the number of sparrows with the total number of birds.

Task 6: Seeds in a packet

In your seed packet you have 8 flower seeds: 5 roses and 3 tulips. What is the probability that a randomly selected seed is a tulip seed?

Tip:

Think about how many total seeds are in the packet. Then count how many of them are tulip seeds. Compare the number of tulip seeds with the number of all seeds.

Task 7: Choosing the stones

You have 5 decorative stones of different colours: white, black, grey, red and yellow. What is the probability that a randomly selected stone will be red?

Hint:

First count how many stones there are in all. Then work out how many of them are red. Divide the number of red stones by the total number of stones.

Activity 8: Fruit in a basket

You have 6 fruits in your basket: 3 apples, 2 pears and 1 plum. What is the probability that a randomly selected fruit is an apple?

Hint:

Count how many fruits are in the basket. Then check how many of them are apples. To find the probability, compare the number of apples with the total number of fruits.

Task 9: Flowers in pots

There are 4 pots in the garden, each with one flower: 1 rose, 1 tulip, 1 lily, 1 daisy. What is the probability that a randomly selected pot contains a lily?

Tip:

Start by counting all the pots. Then check how many of them contain a lily. Compare the number of pots with a lily to the total number of pots.

Task 10: Colours of flowers

There are 7 flowers blooming in the garden: 3 are red, 2 yellow, 1 white and 1 blue. What is the probability that a randomly selected flower will be red?

Hint:

First count how many total flowers there are in the garden. Then work out how many of them are red. Divide the number of red flowers by the total number of flowers.

Attachment No. 4: Elementary tasks in probability calculus (multi-stage event)

Task 1: Bees and flowers

There are 4 flowers in the garden: a rose, a tulip, a lily and a daisy. A bee visits two flowers, one after the other. What is the probability that it will visit the rose first and then the tulip?

Tip: First think about how many flowers a bee might choose to visit first (all are available). Then think about how many flowers are left to choose for the second visit after choosing the first flower. Calculate the probability of each step and then combine them ('multiply both probabilities').

Task 2: Planting plants in pots

You have 3 different species of plants in your garden: roses, tulips and lilies. When planting them in two pots, you choose the order randomly. What is the probability that you will plant a tulip in the first pot and a rose in the second pot?

Tip: First count how many plants there are to choose from for the first pot. Then work out how many plants are left to choose from for the second pot after you have chosen the tulip. Combine these two steps to find the final result.

Task 3: Choosing pots

You have 4 pots: red, green, blue and yellow. You randomly select two pots to plant flowers in. What is the probability that the first pot chosen will be red and the second green?

Tip: To start, think about how many pots are available to choose from first. Then count how many pots are left to choose from in the second step after the red pot is selected. Combine these two steps to find the final probability.

Task 4: Birds in the trees

There are 3 birds in the garden: a sparrow, a titmouse and a starling. One bird sits on an apple tree and the other on a pear tree. What is the probability that the sparrow sits on the apple tree and the titmouse sits on the pear tree?

Tip: First consider how many birds are likely to sit on the apple tree. Then work out how many birds are left to choose from on the pear tree after the apple tree has been occupied by a sparrow. Combine these two steps to get a result.

Task 5: Stones on the path

There are 5 stones on the path: white, black, grey, red and yellow. You randomly choose two stones, one by one. What is the probability that you will choose a white stone and then a black stone?

Tip: Start by counting how many stones are available to choose from at the first stage. Then work out how many stones are left to choose from after you have chosen white. Combine the probabilities of the two stages.

Task 6: Watering the plants

You have 3 different plants: roses, tulips and lilies. You plan to water them in a random order. What is the probability that you will water the roses first and then the lilies?

Tip: First work out how many plants are available for watering at the first stage. Then count how many plants are left to choose from at the second stage after watering the roses. Combine these two steps to find the result.

Task 7: Fish in the pond

There are 4 fish swimming in the pond: 2 carp, 1 carp and 1 goldfish. You randomly catch two fish, one after the other. What is the probability that you catch the carp first and then the goldfish?

Tip: First consider how many fish you can catch in the first stage. Then count how many fish are left to choose from at the second stage after you have caught the carp. Combine these two steps.

Task 8: Flower bouquet

You have 3 types of flowers in your garden: roses, lilies and tulips. You choose two flowers for your bouquet, one after the other. What is the probability that you will choose the lily first and then the rose?

Tip: First consider how many flowers are available to choose from at the first stage. Then work out how many flowers are left to choose from at the second stage after you have chosen the lily. Combine these two steps to find the probability.

Scenario No. 11

"A drop in the ocean... water resources worldwide?"

Workshop Objective:

- Introduce participants to basic information about water resources on our planet. Participants will learn how water is distributed on Earth, how much of it is fresh and available for human use, and the challenges of limited water resources.

- Development of practical skills related to the use of Excel. Participants will learn how to enter data into tables, organise them and present them in the form of graphs. They will learn about different types of charts, such as pie charts (for visualising proportions), bar charts (for comparisons) and line charts (for trend analysis). They will know how to choose the right type of graph for their data, describe it correctly by adding titles, axes and legends, allowing them to better communicate their conclusions.

- Development of data interpretation skills. Once the graphs have been created, participants will learn to read information from them, compare values and draw conclusions.

Duration: 3 hours.

Required Materials:

- Computers adapted to the needs of seniors:

• Each participant should have access to a computer - ideally 1 computer per person, so that everyone can work independently and learn practical skills.

• Computers should have a simple and clear interface, e.g. larger font, and Microsoft Excel installed.

• Optional: ergonomic mice if participants have difficulty using a touchpad.

- Appendix with list of data - list of 15 tasks:

• A finished document (printed and electronic) containing the data to be entered in Excel for all 15 workshop tasks.

• The data should be organised in tables so that participants can easily read and enter them into the worksheets.

- Projector and screen:

• Projector connected to the trainer's computer to present the introduction and instructions to participants.

• Screen or white wall for displaying Excel presentations and demonstrations.

- Note-taking materials (notebooks and pens for participants to record observations and conclusions).

- Prepared sample Excel files.

Workshop Plan:

1. Introduction to the Workshop Topic (20 minutes)

The trainer introduces the group to basic information about water on our planet

Water is the basic element of life on Earth, without which no organism could survive. Although our planet is called the 'Blue Planet' because of its vast water resources, only a small part of this water is available to humans.

The total amount of water on Earth is about 1 386 million cubic kilometres. Most of this water is found in the oceans and seas, accounting for as much as 97.5 per cent of the total resource. This is salt water, which we cannot directly consume or use for agriculture.

Only 2.5% of the Earth's water is freshwater, but even of this small fraction, most is trapped in glaciers and ice caps (68%). About 30% of fresh water is found in deep groundwater and only 0.3% is water in rivers, lakes and reservoirs that is available for human use.

Available water for humans represents only 0.007% of the Earth's total water resources. This means that despite the vast water resources, the available amount of drinking water is limited and prone to pollution and depletion.

The importance of water as a key resource

- Water is the foundation of life, but its role goes beyond biological needs. It is a resource that is vital to the economy, the environment and industry.
- Water is needed for drinking, hygiene and food preparation. Without adequate access to clean water, human health is at risk.
- Water is used in agriculture, which consumes as much as 70% of the world's available freshwater. Industry also depends on water, both for manufacturing processes and for cooling machinery.
- Water is a key element in ecosystems such as rivers, lakes, marshes and oceans. These ecosystems sustain life for millions of species and regulate the Earth's climate.

Water problems around the world

Although water is a renewable resource, a number of factors mean that its availability is under threat.

Lack of access to drinking water:

- More than 2 billion people worldwide do not have access to safe drinking water.
- In sub-Saharan Africa, thousands of women and children walk long kilometres every day to fetch water that is often not clean.

Water pollution:

- Industrial, agricultural and domestic wastewater pollutes rivers, lakes and groundwater.
- Plastics and microplastics end up in the oceans, threatening marine life.

Poor water management:

- Leaking water pipes contribute to huge water losses - in some countries as much as 40% of water from the water system is lost.
- Excessive water use in agriculture leads to depletion of groundwater sources.

Climate change:

- Rising temperatures lead to greater evaporation and more frequent droughts.
- Melting glaciers reduce freshwater reserves.

Water resources in Poland and Germany

Poland - a water-scarce country:

- Poland has very limited freshwater resources. There is about 1 600 m^3 of water per inhabitant per year, which places Poland among the countries with the lowest water resources in Europe.
- In comparison, the European average is around 4 500 m^3 per person per year.

Main problems:

- Uneven distribution of water - regions in the Northeast suffer from water shortages.
- Pollution of rivers and lakes.

Germany - a better situation, but also challenges:

- Germany has more water resources, with about 2 200 m^3 of water per inhabitant per year.
- Germany has a well-developed water infrastructure, which minimises water losses.

Main problems:

- Pollution from agriculture, especially related to the use of fertilisers.
- Increasing pressure on groundwater as a result of climate change and intensive urbanisation.

The importance of water conservation

- Conserving water in everyday life:
- Turning off the tap when brushing your teeth.
- Using water-efficient appliances such as aerators or washing machines that use less water.

Protecting water sources:

- Avoiding the dumping of chemicals and plastics into the environment.
- Improving water supply infrastructure to reduce waste.

Global action:

- Investing in seawater desalination technologies.
- Supporting educational and environmental initiatives that help raise awareness of water conservation.

2. Essential part - 2.5 hours of practical exercises (12 tasks to be completed in Excel, divided into 4 half-hour blocks, with a 10-minute break in between)

During the core part of the workshop, participants work individually on computers using Excel to analyse data on water resources and their use in Europe, Poland and Germany. Each participant is given a set of tasks with data to be entered into the programme, followed by the creation of appropriate graphs and answering questions related to the data.

The facilitator continuously presents all steps on an overhead projector or screen to support participants in completing the tasks. Each task has been planned to take about 10 minutes to complete. At the end of each part, the data and graphs will be discussed in detail so that each participant can make sure they have a good understanding of all the steps and the conclusions drawn.

The exercises are practical in nature - participants experiment with Excel charts and tools on their own, and the trainer is available to answer questions and help in case of difficulties. Working at a relaxed pace and presenting the activities in parallel on an overhead projector will ensure that every participant can handle the tasks with ease.

Tasks for participants:

Task 1: Distribution of water resources on Earth (pie chart)

Data to be entered:

Salt water: 97.5%.

Fresh water: 2,5%.

Question:

What is the percentage of saltwater and freshwater on Earth?

Tip:

Enter the data into an Excel table and then create a pie chart to see the proportions.

Task 2: Division of the Earth's freshwaters (pie chart)

Data to be entered:

Glaciers and ice cover: 68%.

Groundwater: 30%.

Rivers and lakes: 0.3%.

Soils and atmosphere: 1.7%.

Question:

Which freshwater resources are most important and which are most accessible to humans?

Tip:

Create a pie chart with the percentage distribution of freshwater and describe which sources are key.

Task 3: Household water consumption in Poland and Germany (bar chart)

Data to be entered (litres/person/day):

Poland: 150.

Germany: 125.

Italy: 250.

Netherlands: 120.

Question:

What differences in water consumption exist between Poland, Germany and other European countries?

Tip:

Create a bar chart comparing water consumption in different countries.

Task 4: Water resources per capita in selected European countries (bar chart)

Data to be entered (m^3/person/year):

Poland: 1 600.

Germany: 2 200.

France: 3 000.

Norway: 30 000.

Question:

Which European countries have the highest per capita water resources?

Tip:

Create a bar chart and compare the data, marking the countries with the highest and lowest access to water.

Task 5: Share of the agricultural sector in European water consumption (pie chart)

Data to be entered:

Agriculture: 70%.

Industry: 20%.

Households: 10%.

Question:

Which sector uses the most water in Europe?

Tip:

Enter the data in the table and create a pie chart to see the proportions between sectors.

Task 6: Number of rivers over 1 000 km in Europe (bar chart)

Data to be entered:

Poland: 3.

Germany: 5.

France: 4.

Spain: 2.

Question:

How does the number of large rivers vary in selected European countries?

Tip:

Create a bar chart comparing the number of rivers in each country.

Task 7: Water losses in water supply infrastructure (bar chart)

Data to be entered (losses %):

Germany: 5%.

Poland: 20%.

Spain: 15%.

Italy: 25%.

Question:

Which country in Europe has the highest water losses in water supply systems?

Tip:

Create a bar chart to illustrate where the water infrastructure needs the most improvement.

Task 8: Average annual precipitation in Europe (dot plot)

Data to be entered (mm/year):

Poland: 600.

Germany: 800.

Norway: 1 500.

Spain: 450.

Question:

What are the differences in rainfall across Europe?

Tip:

Create a dot plot to show the differences in rainfall between countries.

Task 9: Water consumption in agriculture in Poland and Germany (bar chart)

Data to be entered (% of consumption):

Poland: 60%.

Germany: 40%.

France: 70%.

Italy: 80%.

Question:

How does the share of agriculture in water consumption differ between Poland, Germany and other countries?

Tip:

Create a bar chart and mark the differences in water use.

Task 10: Household drinking water availability in Europe (bar chart)

Data to be entered (%):

Poland: 95%.

Germany: 99%.

Bulgaria: 90%.

Romania: 85%.

Question:

Which countries have the biggest problem with access to drinking water?

Tip:

Create a bar chart and mark the differences in drinking water availability.

Task 11: Energy production using water in Europe (pie chart)

Data to be entered:

Hydroelectric power plants: 60%.

Coal-fired power plants: 25%.

Nuclear power plants: 15%.

Question:

What types of energy production in Europe use water the most?

Tip:

Create a pie chart to illustrate the share of each type of power plant.

Task 12: River pollution in Poland and Germany (bar chart)

Data to be entered (%):

Poland: 20%.

Germany: 15%.

France: 10%.

Czech Republic: 25%.

Question:

How do river pollution levels differ between Poland, Germany and other countries?

Tip:

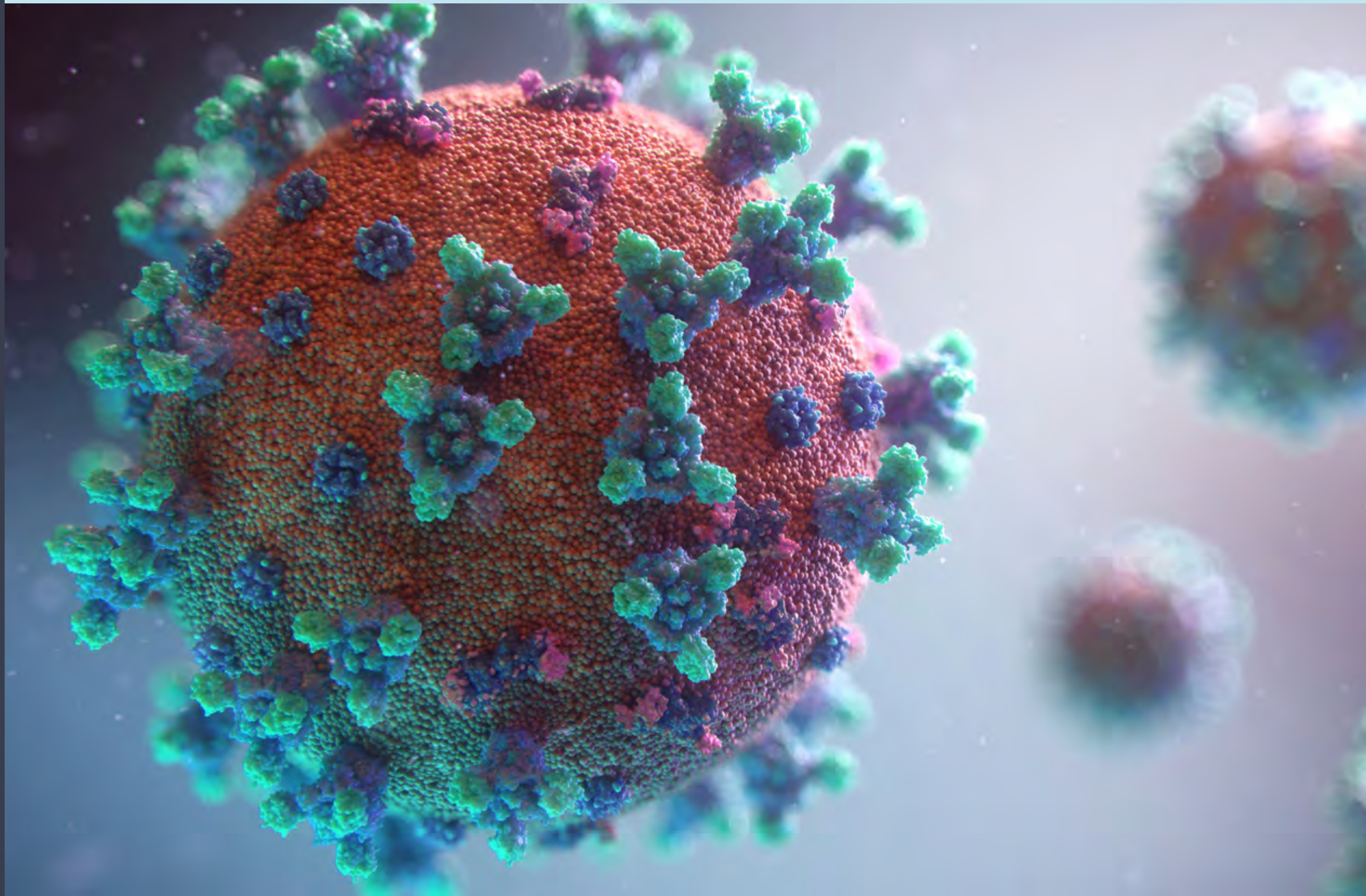
Create a bar chart to see which countries have the biggest problem with surface water cleanliness.

3. Conclusion and evaluation of the workshop (10 minutes)

Aim: To enable participants to reflect on what they have learnt and to gather their feedback on the activities.

Brief evaluation questionnaire of the class - what information was most useful, what they would like to develop in the future.

Scenario No. 12
"Can viruses be counted?"



Workshop Objective:

- Introduction to the concept of exponents – familiarizing participants with the basic principles of exponentiation and its application in everyday life and the analysis of phenomena.

- Arithmetic exercise – developing mathematical calculation skills, such as exponentiating positive numbers, negative numbers, fractions, and interpreting the results.

- Introduction to simple mathematical modeling – presenting the SIR model (susceptible, infected, recovered), which illustrates the dynamics of an epidemic.

- Mathematics in nature – applying exponentiation and mathematical analysis in natural phenomena, including pandemics.

- Understanding the scale of virus spread – analyzing how changes in parameters can affect the number of infected individuals.

- Familiarization with interesting mathematical paradoxes – for example, how small changes in initial parameters can lead to significant differences in results.

- Application of mathematics to make informed decisions – how to interpret numerical data related to pandemics (e.g., the R0 index).

- Building skills for group work and individual problem-solving – developing the ability to approach and solve mathematical problems.

Duration: 3 hours.

Required Materials:

- Calculators adapted for the needs of seniors – large buttons, easy-to-read displays.
- Whiteboards – for recording results and explaining mathematical models.
- Attachment No. 1: Modeling the Number of Infected
- Attachment No. 2: Introduction to the SIR Mathematical Model
- Attachment No. 3: Practical Tasks – Number of Infected and the Impact of Vaccinations
- Attachment No. 4: Practical Examples – Exponentiation and Percentage Calculations
- Attachment No. 5: Herd Immunity – Calculations and Strategy

1. Introduction to the Workshop Topic (20 minutes)

Topic: Using the example of the COVID-19 pandemic, we will explain how mathematics helps understand the spread of viruses. Introduction to the concept of exponents and their role in mathematical modeling.

Content:

- A brief reminder of the COVID-19 pandemic – how important mathematical analysis was (e.g., the R0 index).
- Introduction to the SIR mathematical model – what the groups of susceptible, infected, and recovered individuals are, and how their numbers change over time (Attachment No. 2).
- Explanation of the role of exponents in modeling (e.g., the number of infected individuals increases exponentially when the R0 index is greater than 1).

2. Theory and Practical Exercises (2.5 hours, including a 10-minute break)

2.1. Introduction to the Concept of Exponents (45 minutes)

The facilitator provides the definition of an exponent:
An exponent is a way of writing repeated multiplication of the same number. An exponential expression consists of two elements:

Base – the number that is being multiplied (e.g., 2).

Exponent – the number that indicates how many times the base should be multiplied by itself (e.g., 3).

On the board, the facilitator writes:
The expression a^b means:

$a^b = a \times a \times a \ldots$ (b times).

Example:

$2^3 = 2 \times 2 \times 2 = 8$,

$5^4 = 5 \times 5 \times 5 \times 5 = 625$.

When writing examples, the facilitator highlights the base of the exponent and the exponent itself – at this stage, they discuss exponents with a positive natural base and the same exponent.

After presenting the definition of an exponent and basic examples, the facilitator lists the fundamental rules of exponentiation:

- If the base is a positive number and the exponent is a positive integer, the result of exponentiation will be positive.

Example:

$3^2 = 3 \times 3 = 9$.

- If the base is a negative number, the result depends on the parity of the exponent.

For an even exponent, the result is positive.

Example:

$(-2)^4 = (-2) \times (-2) \times (-2) \times (-2) = 16$.

For an odd exponent, the result is negative.

Example:

$(-2)^3 = (-2) \times (-2) \times (-2) = -8$.

By definition, any number other than zero raised to the power of zero gives the result 1.

Example:

$5^0 = 1$,

$(-3)^0 = 1$.

- In the case of fractions, both the numerator and the denominator are raised to the power.

The facilitator then presents examples of the use of exponentiation in the pandemic to the seniors – based on Attachment No. 1.

Modeling the Number of Infected
If one person infects an average of 2 others each day, then after n days, the number of infected individuals is 2^n.

Example:

Po 3 dniach: $2^3 = 2 \times 2 \times 2 = 8$.

This means that 8 people will become infected.

Comparison of Dynamics with Different Indicators R_0
The R_0 (basic reproduction number) represents the average number of people infected by one person.

Depending on R_0:

$R_0 = 1$ (the number of infected individuals does not increase over time),
$R_0 = 2$ (the number of infected individuals increases exponentially).

Example:

With $R_0 = 3$, the number of infected individuals after 4 days will be:

$3^4 = 3 \times 3 \times 3 \times 3 = 81$.
The facilitator then presents the SIR model to the group – based on Attachment No. 2.

The SIR model divides the population into three groups:

- S (Susceptible): Individuals who can become infected.

- I (Infected): Individuals who are sick and can infect others.

- R (Recovered): Individuals who have recovered or have been vaccinated and cannot be infected.

The facilitator then discusses the examples in the attachment, explaining to the participants the relationships between the groups.

2.2. Practical Tasks Related to Viruses – Group Work (30 minutes)

The facilitator divides the group into smaller teams (3-4 people in each team). The teams work with Attachment No. 3 – solving practical tasks related to the number of infections (exponentiation, percentage calculations). They may use basic calculators for this purpose.

- Calculate the number of infected individuals after 5 days if one person infects an average of 3 others.
- How many people will be infected after 7 days with an R_0 of 1.5?
- If 10% of the population is vaccinated, calculate by how much the number of susceptible individuals will decrease.
- With an R_0 of 2, calculate the difference in the number of infected individuals between the 3rd and 5th days.
- Calculate how many people in the population will remain infected if 70% get vaccinated.

After solving the tasks in groups, the facilitator leads a discussion about the impact of vaccinations on the progress of the pandemic.

2.3. Practical Tasks Related to Viruses – Individual Work (30 minutes)

Participants will then work independently on 10 examples requiring exponentiation and percentage calculations – Attachment No. 4.

- Calculate the number of infected individuals after 4 days if one person infects an average of 2 others.
- In a population of 100 people, one person is infected, and the R_0 is 3. Calculate how many people will be infected after 3 days.
- Calculate how many people will be vaccinated in a population of 200 people if 20% decide to get vaccinated.
- With an R_0 of 1.5, calculate how many more people will be infected after 3 days than after 1 day.
- Calculate how many people will remain susceptible to infection if 40% of a population of 300 people gets vaccinated.
- If one person infects an average of 2 others, how many people will be infected after 6 days?

- If in a population of 500 people, 50 have been vaccinated, calculate what percentage of the population remains susceptible to infection.

- Calculate the number of infected individuals if the R_0 = 2 and 3 people are initially infected. After 2 days, how many will be infected?

- The R0 dropped from 3 to 1.5 due to intervention. Calculate how many fewer people will be infected after 3 days.

- Calculate the difference in the number of infected individuals after 4 days if the R_0 = 2 compared to R_0 = 1.5.2.4.

Group Task – Poster Illustrating Virus Spread and the Importance of Hygiene and Vaccination (25 minutes) Participants work in small groups. The goals of the task include:

- Understanding the dynamics of virus spread through visualization (diagrams and graphs).

- Raising awareness about the importance of hygiene and vaccinations in reducing the number of infections.

- Teamwork Exercise and Creative Presentation of Information

The facilitator reminds the participants that epidemics develop dynamically, and the lack of actions such as social distancing, hygiene, or vaccinations leads to a rapid increase in the number of infections. The facilitator explains that the group's task will be to prepare a poster illustrating the dynamics of infections and conclusions about preventive measures.

Each group receives:

- Sheets of paper (poster board), colored markers.

- Calculators.

- Task guidelines (in the form of handout sheets).

Mathematical Part:

The group calculates the number of infected individuals each day:

Day 1: $2^1 = 2$
Day 2: $2^2 = 4$
Day 3: $2^3 = 8$
Day 4: $2^4 = 16$

On the poster, the group illustrates the spread of the virus using a tree diagram of infections.

The group adds conclusions about actions that prevent the spread of the virus, such as:

- Importance of hand hygiene (reducing contact with the virus).
- Importance of social distancing (lowering R_0).
- Importance of vaccinations (reducing the number of susceptible individuals).

3. Poster Presentations (5 minutes)
Each group has 1-2 minutes to present their poster.
The presentation should include:

- A brief analysis of the number of infections after 3 and 4 days.
- An explanation of the visualization (e.g., how the graph/diagram works).
- An educational message about hygiene and vaccinations.

2.5. Herd Immunity – Individual Task (10 minutes)

Participants work independently to solve the task provided in Attachment No. 5:

Imagine that your town has a population of 1,000 people, and the virus's reproduction rate is

$R_0 = 3$. To stop the virus from spreading, at least $1-1/R_0$ of the population must be immune.

Your task is to answer the following questions:

Calculate what percentage of the population needs to be vaccinated to achieve herd immunity.

How many people need to be vaccinated in a population of 1,000 people?

Assume that only 600 people have been vaccinated. How many more are needed to achieve herd immunity? Will it be enough to stop the virus?

If the R_0 rate can be reduced to 2 through mask-wearing and social distancing, calculate what percentage of the population needs to be vaccinated in this case.

Based on your calculations, propose a strategy to reduce the number of infected people.

3. Conclusion and Workshop Evaluation (10 minutes)

Objective: Allow participants to reflect on the knowledge they have gained and collect their feedback about the session.

Short evaluation survey: Which information was most useful, and what would participants like to explore further in the future?

Homework (to be completed individually by participants):

Homework Task 1: Imagine that one person infects an average of 3 others each day.

Calculate how many people will be infected after:

1 day:

2 days:

3 days:

4 days:

Additional Question: How would the number of infections change if each person infected only one other person per day ($R_0 = 1$)?

Homework Task 2: In your homemade yogurt, there are initially 10 probiotic bacteria. The number of bacteria doubles every hour. Calculate how many bacteria there will be after:

1 hour:

3 hours:

6 hours:

How would the number of bacteria change if their growth was slower (increasing by only 1.5 times each hour)?

Homework Task 3: In a forest, trees are planted such that the number of new trees doubles every year. Initially, 10 trees are planted per year.

How many trees will be planted in total after 5 years?

Attachment No. 1 – Modeling the Number of Infected

During a pandemic, mathematical models help to understand how quickly the virus spreads. A key role is played by the so-called basic reproduction number R_0, which indicates how many people, on average, are infected by one sick person.

If one person infects an average of R_0 additional people each day, then after n days, the number of infected individuals is $(R_0)^n$.

Example 1: $R_0 = 2$

Let us assume that the basic reproduction number $R_0 = 2$, meaning each person infects 2 additional individuals each day. After n days, the number of infected individuals is: 2^n.

Calculations:

Day 0 (initially one infected person):

$2^0 = 1$

Day 1:

$2^1 = 2$

Day 2:

$2^2 = 4$

Day 3:

$2^3 = 8$

Day 4:

$2^4 = 16$

Conclusion:

If the basic reproduction number $R_0 = 2$, the number of infected individuals grows exponentially. After 4 days, the total number of infected individuals is 16.

Example 2: $R_0 = 3$

Let us assume that this time the basic reproduction number $R_0 = 3$, meaning each person infects 3 additional individuals each day. After n days, the number of infected individuals is: 3n.

Calculations:
Day 0 (initially one infected person):

$3^0 = 1$

Day 1:

$3^1 = 3$

Day 2:

$3^2 = 9$

Day 3:

$3^3 = 27$

Day 4:

$3^4 = 81$

Conclusion:
With a reproduction number $R_0 = 3$, the number of infected individuals grows faster than with

$R_0 = 2$. After 4 days, the total number of infected individuals is 81.

Insights:

With $R_0 = 1$, the number of infected individuals does not increase—this indicates stabilization of the epidemic.

With $R_0 = 2$, the number of infected individuals grows exponentially, but at a slower rate compared to a higher reproduction number.

With $R_0 = 3$, the spread is significantly faster, highlighting the need to reduce the reproduction number, for example, through vaccination or social distancing.

Calculate how many people will be infected after 5 days if:

$R_0 = 2$

$R_0 = 3$.

Application of the Model in Practice

Mathematical models demonstrate why actions such as vaccination or social distancing are crucial in limiting a pandemic:

With a reproduction number R_0 =1.5, the spread of the virus slows significantly.

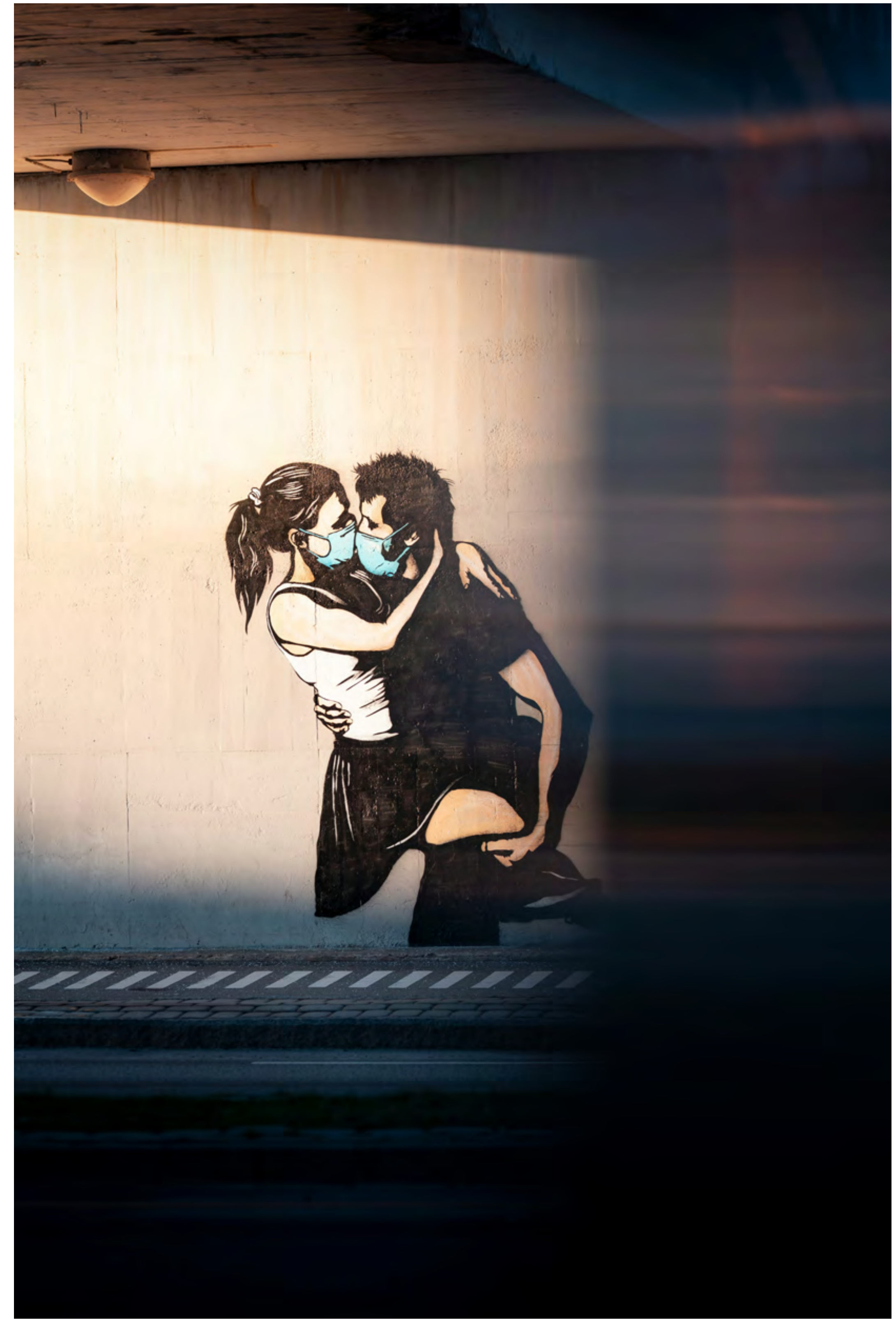
Vaccination: The more people are vaccinated, the fewer individuals remain susceptible to infection.

Example:

If R_0 =1.5, the number of infected individuals after 4 days is:

$(1.5)^4 = 1.5 \times 1.5 \times 1.5 \times 1.5 = 5.0625$

This significantly slows down the spread of the virus.



Attachment No. 2 – Introduction to the SIR Mathematical Model

The SIR model is one of the fundamental mathematical models used to describe the spread of infectious diseases. It divides the population into three groups:

S ("Susceptible"): Individuals who can become infected.
The number of susceptible individuals decreases over time as some people get infected.
Denotation: S(t), where t represents time.

I ("Infected"): Individuals who are sick and can infect others.
The number of infected individuals first increases, reaches a peak, and then decreases as more people recover or are vaccinated.
Denotation: I(t).

R ("Recovered"): Individuals who have recovered, been vaccinated, or died and can no longer be infected.
The number of immune individuals increases over time as more people leave the infected group.
Denotation: R(t).

Example 1: Initial Population Distribution
At the beginning of an epidemic, most of the population is susceptible to infection, while the number of infected and immune individuals is small.
Let us assume a population of 100 people:

Start of the epidemic (Day 0): S(0)=98 (98 susceptible individuals),
I(0)=2 (2 infected individuals),

R(0)=0 (no one has recovered yet).

Example 2: Dynamics Over Time
With a basic reproduction number

R_0 =2, each infected person infects 2 additional individuals daily. The population is divided into the groups S, I, and R.

The number of susceptible individuals decreases by 4 people:

$S(1) = 98 - 4 = 94$.

The number of infected individuals increases:

$I(1) = 2 + 4 = 6$.

The number of immune individuals remains unchanged:

$R(1) = 0$.

Day 2: Infected individuals ($I=6$) infect $6 \times 2 = 12$ people.

The number of susceptible individuals decreases by 12.

$S(2) = 94 - 12 = 82$.

The number of infected individuals increases.

$I(2) = 6 + 12 = 18$.

The number of immune individuals still stands at:

$R(2) = 0$.

Day 3: Infected individuals ($I=18$) infect $18 \times 2 = 36$ people.

The number of susceptible individuals decreases.

$S(3) = 82 - 36 = 46$.

The number of infected individuals increases.

$I(3) = 18 + 36 = 54$.

The number of immune individuals begins to increase – the first infected individuals have recovered (let us assume the illness lasts for 2 days).

$R(3) = 2$.

Example 3: The Epidemic Subsides

After some time, the number of susceptible individuals drops to zero, the number of infected individuals decreases, and most of the population becomes immune.

Day 10:
Let us assume that after 10 days:

$S(10) = 0$ (no one is susceptible to infection anymore),

$I(10) = 2$ (2 infected individuals remain, who will recover within 2 days), R(10)=98(98 individuals are immune).

Conclusions from the SIR Model

- The importance of reducing the R_0 rate:

The higher the basic reproduction number (R_0), the faster the number of infected individuals grows. Actions such as social distancing, hygiene, or vaccination reduce R0 , slowing the spread of the virus.ają R_0, slowing the spread of the virus.

- The role of so-called "herd immunity”:

If the majority of the population becomes immune (at least 70%), the epidemic subsides because there are no longer enough susceptible individuals to sustain the spread.

- Balance between groups::

At the peak of the epidemic, the number of infected individuals is at its highest, but at the same time, the number of susceptible individuals decreases rapidly. This is the critical point after which the epidemic begins to decline.

Application in a Pandemic:

The SIR model helps to predict:

- How the number of infected individuals changes over time.
- Which measures to reduce R_0 are most effective.
- When the epidemic will reach its peak and start to subside.

Attachment No. 3 – Practical Tasks – Number of Infected and the Impact of Vaccinations

Instructions for the Groups:
Complete the following tasks using calculators. Each task requires calculations regarding the number of infected individuals or the population. Collaborate in groups to find the solutions and record your results.
At the end, prepare a brief summary of the conclusions from the task, focusing on the impact of vaccinations and preventive measures on the number of infections.

Task 1: Number of infected individuals after 5 days with the reproduction number R_0 =3

Description:

Each infected person infects 3 others every day. Initially, there is 1 infected person. The number of infected individuals each day is given by

Step-by-Step Solution:

Day 1: $3^1 = 3$

Day 2: $3^2 =$ ....

Day 3: ....

Day 4: ....

Day 5: ....

Result: After 5 days, the number of infected individuals will be .... people.

Task 2: Number of infected individuals after 7 days with the reproduction number.

$R_0 = 1.5$.

Description:

Each person infects an average of 1.5 people every day. Initially, there is 1 infected person.

Rozwiązanie krok po kroku:

Day 1: $(1.5)^1 = 1.5$

Day 2: $(1.5)^2 =$ ....

Day 4: ....

Day 5: ....

Day 6: ....

Day 7: ....

Result:

After 7 days, the number of infected individuals will be approximately .... people.

Description:
The population consists of 1000 people. Vaccinations cover 10% of the population.

Step-by-Step Solution:
Number of vaccinated individuals:

....

Number of susceptible individuals after vaccination:

....

The number of susceptible individuals decreased by:

...... people.

Task 4: The difference in the number of infected individuals between the 3rd and 5th day with the reproduction number $R_0 = 2$.

Description:

The number of infected individuals grows exponentially (2^n). You need to calculate the number of infected individuals on the 3rd and 5th days, and then find the difference.

Step-by-Step Solution:

Number of infected individuals after 3 days:

....

Number of infected individuals after 5 days:

....

Difference:

....

Result: Between the 3rd and 5th days, the number of infected individuals increased by .... people.

Task 5:
Calculating the number of infected individuals with 70% vaccinated in a population of 25,000.

Input Data:

Population: 25,000

Percentage vaccinated: 70%

Percentage susceptible to infection:

……………………………………

Calculating the number of susceptible individuals:

……………………………………

Result:
From a population of 25,000, if 70% of individuals are vaccinated, ……… people will remain susceptible to infection.

Discussion (after completing the tasks):
Questions for the groups:

What observations can be made from the dynamics of infections with different values of $R_{0?}$

- How does the number of infected individuals change when more people are vaccinated? What does this tell us about herd immunity?

- Is it worth investing in vaccinations to reduce the number of susceptible individuals? Why?

Final Conclusions:

- The number of infected individuals grows exponentially if
  $R_0 > 1$ (the facilitator can present the group with a graph of an exponential function with a base greater than 1 – a discussion about whether this is a model they recognize from the COVID-19 pandemic).

- Vaccination is crucial in reducing the number of susceptible individuals.

- The higher the percentage of vaccinated individuals, the slower the virus spreads, until the epidemic eventually subsides.

Attachment No. 4 – Practical Examples – Exponentiation and Percentage Calculations

1. Calculate the number of infected individuals after 4 days, if one person infects an average of 2 others.

Data:

$R_0 = 2$,

$n = 4$.

Calculation:

Number of infected individuals:

……………………………………

……………………………………

Result: After 4 days, the number of infected individuals will be ……… people.

2. In a population of 100 people, one person is infected, and the reproduction number $R_0 = 3$. Calculate how many people will be infected after 3 days.

Data:

Initial number of infected: $I_0 = 1$

$R_0 = 3$

$n=3$.

Calculation:

……………………………………

……………………………………

Result: After 3 days, the number of infected individuals will be ……… people.

3. Calculate how many people will be vaccinated in a population of 200 people if 20% decide to get vaccinated.

Data:

Population: $N = 200$

Percentage vaccinated: 20%.

Calculation:

Number of vaccinated individuals:

………………………………………

………………………………………

Result: The number of vaccinated individuals will be ……… people.

4. With a reproduction number R_0 =1.5, calculate how many more people will be infected after 3 days compared to after 1 day.

Data:

R_0 = 1.5

Days n = 3.

Calculation:

………………………………………

………………………………………

Result: After 3 days, the number of infected individuals will increase by ……… people.

5. Calculate how many people will remain susceptible to infection if 40% of a population of 300 people get vaccinated.

Data:

Population: N=300

Percentage vaccinated: 40%

Calculation:

………………………………………

………………………………………

Result: The number of susceptible individuals will be ……… people.

6. If one person infects an average of 2 others, how many people will be infected after 6 days?

Data:

R_0 =2

n=6

Calculation:

………………………………………

Result: After 6 days, the number of infected individuals will be ……… people.

7. If in a population of 500 people, 50 have been vaccinated, calculate what percentage of the population remains susceptible to infection.
Data:
Population:

$N=500$
Number of vaccinated individuals: 50

Calculation:

……………………………………….

……………………………………….

Result: The number of susceptible individuals remains ……… of the population.

8. Calculate the number of infected individuals if the reproduction number

$R_0 = 2$ and 3 people are initially infected. After 2 days, how many people will be infected?

Calculation:
……………………………………….

Result: After 2 days, the number of infected individuals will be ……… people.

9. The reproduction number R_0 decreased from 3 to 1.5 due to an intervention. Calculate how many fewer people will be infected after 3 days.
Data:
Before the intervention:

$R_0=3$

After the intervention:

$R_0 = 1.5$

$n=3$

Calculation:
……………………………………….
……………………………………….

Result: Due to the intervention, the number of infected individuals decreased by approximately ……… people.

10. Calculate the difference in the number of infected individuals after 4 days, if the reproduction number R_0=2compared to R_0 =1.5.

Data:

Reproduction numbers:

$R_0 = 2$

$R_0 = 1.5$

$n = 4$

Calculation:

………………………………………

………………………………………

Result: After 4 days, the difference is approximately ……… people.

Attachment No. 5 – Herd Immunity – Calculations and Strategy

Herd immunity is the point at which a sufficient portion of the population becomes immune to a disease (through vaccination or recovery), which prevents the virus from spreading freely.

The reproduction number R_0 indicates how many people, on average, one infected person will infect. For the virus to stop spreading, at least:

$1 - R_0\ 1$

of the population must be immune.

Your task is to analyze the situation in a town with a population of 1,000 people, where

$R_0 = 3$.

Task 1: Calculate what percentage of the population must be vaccinated to achieve herd immunity.

Formula

…………………………………………

…………………………………………

Result: To achieve herd immunity, ………% of the population must be vaccinated.

Task 2: How many people need to be vaccinated in a population of 1,000 people?

Data:

Population: 1000

Percentage vaccinated: ………% (calculated in Task 1)

Calculation:

…………………………………………

…………………………………………

Result: To achieve herd immunity, …… individuals need to be vaccinated.

Task 3: Assume that only 600 people have been vaccinated. How many are still needed to achieve herd immunity? Will it be possible to stop the virus?

Calculation of missing individuals:

………………………………………

………………………………………

Result:

There are still …… people needed to achieve herd immunity.

Since the herd immunity threshold has not been reached, the virus will continue to spread

Task 4: If the R_0 can be reduced to 2 due to wearing masks and social distancing, calculate what percentage of the population must be vaccinated in this case.

Calculation:

………………………………………

………………………………………

………………………………………

………………………………………

Result: With R_0 =2, ……% of the population must be vaccinated.

SUMMARY

Conclusions from the Scaling Process of the Developed Educational Offering

As part of the project "EkoLOGIKA – Developing Basic Skills for Socially Excluded Adults," each project partner, including the action coordinator—Fundacja Inthinknity—and the German partner, Verein zur Förderung von Beschäftigung und Qualifizierung Bad Freienwalde e.V., conducted a series of educational workshops aimed at scaling up the developed offering and finalizing its adaptation to the real needs of seniors.

Each partner organized 12 three-hour workshops, attended by 50 seniors aged 60 and above. These workshops were a key component of the evaluation process for the designed educational program, which integrated mathematics learning with environmental topics. Over the course of 12 sessions, the seniors had the opportunity to tackle a variety of tasks aimed at enhancing their mathematical skills while simultaneously increasing their ecological awareness.

During the workshops, particular emphasis was placed on the practicality and everyday application of the acquired knowledge. Participants engaged in tasks directly relevant to their lives—such as calculating energy and water consumption costs and assessing the benefits of investing in eco-friendly technologies, like solar panels. This approach aimed to show seniors how mathematics can influence their daily decisions and how understanding numbers can improve their quality of life—both ecologically and financially.

The workshops revealed that participation not only allowed attendees to develop specific mathematical skills but also helped them realize how they could use this knowledge to make more informed choices in managing their resources, including finances, water, and energy, and in making environmentally friendly decisions in daily life. The primary goal of these workshops was to test and refine the educational offering by gathering feedback and suggestions from participants, providing valuable insights for the program's further development.

After conducting the workshops, educators carried out a detailed evaluation of the results, allowing for final adjustments to be made and for the program to be tailored to the real needs of seniors. This process made it possible to create an educational offering that better addresses the challenges of teaching mathematics and ecology to older adults, considering their skill levels and learning preferences. The aim was not only to impart theoretical knowledge but, more importantly, to develop tools that would enable seniors to actively engage in a rapidly changing world, both financially and ecologically.

As a summary of the publication, we present the eight most important conclusions from the evaluation process, which will be valuable when conducting workshops. These insights were drawn from the experiences gained during the project and are intended to support educators in effectively teaching seniors by combining mathematics with environmental topics.

1. Adjusting the Learning Pace and Flexibility in Approach to the Group

During the workshops for seniors, a wide variety in mathematical skill levels was observed, posing one of the main challenges in the teaching process. Among the participants were individuals struggling with basic arithmetic operations, such as addition, subtraction, and calculating percentages, as well as others who demonstrated higher proficiency in these areas. This diversity in skill level required educators to be highly flexible and adept at adjusting the learning pace to meet individual needs.

For this reason, adapting the pace to the group's level of advancement is an essential aspect of conducting workshops. Educators should ensure that tasks are not too difficult for beginners, while also not neglecting the more advanced participants who need challenges. A pace that is too fast can lead to frustration among those who are less advanced, whereas a pace that is too slow can cause boredom among those who have mastered the basics. Therefore, it is crucial that each senior feels comfortable and, at the same time, motivated to progress.

After conducting the workshops, educators carried out a detailed evaluation of the results, allowing for final adjustments to be made and for the program to be tailored to the real needs of seniors. This process made it possible to create an educational offering that better addresses the challenges of teaching mathematics and ecology to older adults, considering their skill levels and learning preferences. The aim was not only to impart theoretical knowledge but, more importantly, to develop tools that would enable seniors to actively engage in a rapidly changing world, both financially and ecologically.

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2. 2. Increasing Motivation by Combining Mathematics with Ecology

Combining mathematics with ecology proved to be a highly effective tool in enhancing seniors' motivation to actively participate in the workshops. Seniors were more eager to engage in sessions when they could see the direct benefits of learning mathematics, especially when its practical applications in daily life became evident. As they began to understand how skills such as calculating percentages, savings, or energy consumption impact their everyday decisions, math became more appealing and less abstract.

Tasks that combined mathematics with ecology—such as calculating savings from using energy-efficient light bulbs or estimating household water usage—sparked significant interest. Seniors realized how simple mathematical calculations could help reduce living costs and positively impact the environment, which further strengthened their motivation to learn.

Ecological tasks that integrated mathematics, such as calculating how many natural resources—like water or energy—could be saved through more conscious and eco-friendly decisions, were especially valued by participants. These tasks not only developed mathematical skills but also effectively raised ecological awareness among seniors. Participants learned how their daily habits, such as conserving water, switching to energy-efficient lighting, or reducing plastic use, could contribute to environmental protection. This knowledge was particularly meaningful, as it provided them with a sense that their actions have a tangible impact on the world around them.

The integration of mathematics with ecology not only made learning more appealing but also demonstrated to seniors that math is a tool with measurable and positive consequences in their everyday lives—both financially and ecologically.

We recommend dedicating as much time as possible to practical tasks, using them as opportunities to introduce mathematical concepts naturally along the way.

3. Practical Approach and Concrete Tools

A practical approach to learning mathematics, centered on real-life tasks, proved crucial for engaging seniors and enhancing learning effectiveness. Workshop participants responded very positively to exercises related to financial management, such as calculating percentages, discounts, and price changes. These examples illustrated how mathematics can directly influence their daily lives, enabling them to make informed financial decisions, like evaluating shopping offers or calculating savings from various options. This practical application helped seniors see that math is a tool that can aid in more efficient household budgeting, which boosted their motivation to learn.

To further strengthen participant engagement, it is important to avoid teaching abstract mathematical theories that may feel distant and difficult to apply in everyday life. Instead, the focus should be on practical mathematics—concepts that directly address their daily challenges.

Real-life examples, such as calculating housing expenses, forecasting energy costs, or planning shopping budgets, help seniors see the tangible applications of mathematics. This approach makes math more understandable and useful, as well as less intimidating and more approachable.

At the same time, to support participants in learning math—especially those who struggle with calculations (low numeracy skills)—it is beneficial to invest in appropriate supportive tools. Calculators with large buttons provide essential assistance. The availability of calculators not only makes calculations easier but also gives seniors a sense of comfort and confidence, which is crucial in the learning process ("I won't be judged for not being able to calculate something correctly"). Technological support enables them to make mathematical decisions more independently, without fear of mistakes, which can lead to greater self-reliance in daily matters.

4. Importance of Repetition and Problem Solving on the Board (Writing Out Calculations)

During educational workshops with seniors, educators observed that one of the key challenges in learning mathematics is the difficulty in retaining new information, especially with more complex topics. To facilitate material retention, particularly for challenging subjects, frequent use of the board to write out calculations and repeated practice proved highly effective. Writing calculations on the board not only helped reinforce information but also made it easier to understand the step-by-step process of solving mathematical problems.

Writing out calculations on the board offers several significant benefits. Firstly, it provides participants with a clear view of the entire process, allowing them to follow each stage of problem-solving more effectively. For more complex topics, such as calculating percentages, solving equations (proportions), or unit conversions, displaying the steps on the board enables participants to see in real-time how each mathematical step leads to the final solution.

Regular repetition of material on the board is also critical in helping seniors retain information. Older adults often need additional time to process and memorize new mathematical concepts. Repeating the same steps in various contexts enables them to build confidence in solving similar problems in the future. Through repetition, math becomes more approachable, and participants begin to see connections between different topics, making it easier to learn.

The way calculations are written on the board also significantly impacts how participants absorb the material. Educators should write out each step of the calculations while explaining them in real-time, so seniors can understand the purpose behind each action. It is also important to highlight that writing calculations on the board is an effective method for seniors who are visual learners. By seeing the steps written out, they can more easily grasp key details, such as formulas or patterns, that assist them in solving the problem. For many participants, this visual form of learning serves as a reference point that supports their working memory.

5. Supporting Independence Through Homework Assignments

During the workshops, homework assignments proved to be an extremely effective tool in the learning process for seniors. Providing worksheets for them to complete at home allowed for independent review and reinforcement of the material covered. Homework enabled participants to work at their own pace, which facilitated a better understanding of more challenging mathematical concepts, such as calculating percentages, solving equations, or unit conversions.

One of the main benefits of introducing homework was the opportunity for seniors to revisit difficult topics in the comfort of their own homes, giving them a chance to gain a deeper understanding of the material without time pressure. Working independently allowed them to focus on areas of mathematics they found most challenging. It also provided a chance to rethink solutions and absorb knowledge more thoroughly before the next session. This approach made reviewing material more manageable and gave seniors a sense of control over their learning.

Homework assignments also served a motivational function. Seniors felt more accountable for their learning when they could independently tackle tasks and test their skills. Often, when they encountered difficulties, they would revisit the tasks in the next workshop, discussing them with the educator or other participants. This made the learning process more interactive, and seniors felt more engaged.

To ensure homework brings tangible benefits, it’s important that the material is accessible enough for seniors to work on it at their own convenience. Worksheets should be tailored to participants’ skill levels, with clear instructions and examples to assist in problem-solving. It’s essential to avoid overly complex tasks that could lead to frustration and discourage learning. Providing a variety of exercises—from simple activities reinforcing the basics to more advanced tasks—allows for gradual skill development.

Additionally, seniors should have the option to seek guidance if needed. Educators should encourage participants to reach out if they encounter difficulties and offer support to clarify challenging concepts.

6. Emotional Support and Patience

Building confidence among seniors is a key element of effective math teaching. Many workshop participants, who had previously experienced negative encounters with math, especially in their younger years, needed significant emotional support. They often faced internal barriers rooted in a fear of numbers or the belief that math is too difficult, incomprehensible, or simply "no longer useful." In these cases, the educator's patience is essential. Participants must feel they have the space to make mistakes and understand that it’s perfectly acceptable for the learning process to take time. Often, the challenges they face are not directly related to the material itself but rather to their own fears and doubts about learning and its relevance.

Thus, the educator’s role in this context extends beyond teaching; it also involves providing emotional support.

It is essential for educators to show empathy and understanding, recognizing the emotional aspects of learning. Seniors who may feel uncertain need extra motivation and reassurance that their efforts are appreciated. Supporting them in building confidence through positive feedback and patiently explaining challenging concepts fosters an environment where anxiety and stress related to math are reduced. Sometimes, a simple reminder that perfection is not expected—and that the learning process itself is valuable—can ease pressure and encourage persistence.

Another critical aspect of teaching seniors is reinforcing positive motivation. It's important to show participants how math can genuinely improve their quality of life. Practical examples—such as how math aids in managing a household budget, calculating energy savings, or analyzing discounts and shopping deals—can be especially motivating, helping seniors see the real-world value in their learning.

By showing seniors that skills like calculating percentages or costs have direct value in their lives, educators can significantly boost their engagement. Recognizing progress, even small achievements, also plays a crucial role. Seniors are often pleasantly surprised to realize how much they've learned, even when it initially seemed unattainable. Visible progress, even in minor tasks, serves as powerful motivation. Educators should regularly highlight these small successes and celebrate achievements, as this not only strengthens seniors' confidence but also encourages them to continue learning. Reinforcing positive motivation by acknowledging even the smallest steps forward makes seniors feel more motivated to keep working, which in turn fosters their further development.

7. Interactive Sessions and Group Engagement

Group work has proven to be one of the most effective ways to engage seniors in learning mathematics and ecology. Collaborative problem-solving in math and ecological tasks created a space for exchanging experiences, ideas, and insights, which significantly enhanced the learning process and boosted participant engagement. When seniors work together in groups, they have the opportunity to support each other, share observations, and assist one another during challenging moments. This collaboration not only promotes a deeper understanding of the material but also fosters social integration, which is especially important for seniors who may experience feelings of loneliness or social exclusion.

Group discussions on math and ecological problems help participants absorb knowledge more effectively. Through mutual support and idea-sharing, participants can explore new perspectives and problem-solving strategies, which enhances their confidence and motivation to continue learning.

Often, those who initially felt uncertain about tackling more challenging tasks gain confidence when they see their ideas are valued by others. Additionally, during these discussions, seniors realize they are not alone in facing difficulties, and working together fosters a sense of belonging within the group.

Group learning in math and ecology has further benefits. By participating in teamwork, seniors develop social skills such as communication, cooperation, and conflict resolution, which are especially important for social integration. Collaborative problem-solving allows participants to better understand concepts that might seem difficult to grasp individually. The opportunity to ask questions and share ideas in a group setting makes learning more interactive and accessible, especially for seniors who may feel discouraged or overwhelmed when working alone.

It's also important to note that group work not only facilitates learning but also strengthens a sense of belonging within the community. Learning together becomes an opportunity to form new friendships, build relationships, and foster a sense of community. For many seniors who may struggle with loneliness, regularly participating in such interactive sessions can be a source of joy and satisfaction, positively impacting their mental and emotional well-being.

8. Necessary Changes in Senior Education

Educational programs for seniors must be especially flexible and tailored to their specific needs and abilities. Compared to other age groups, seniors often face various challenges that can hinder the assimilation of new information. Therefore, educational programs should accommodate not only differences in math skill levels but also individual limitations related to age, life experience, and health status.

It is essential for classes to be designed in a way that allows them to adapt to the diverse needs of participants, accommodating both those who are just beginning their journey with mathematics and those who already have some foundational knowledge and need more advanced support.

Classes for seniors should be primarily practical, directly linked to their everyday lives and challenges. Mathematics should become a tool that helps seniors better manage their finances, understand commercial offers, and make informed ecological decisions, such as saving water or energy. Educational programs should focus on real-life problems that seniors encounter daily, such as calculating household expenses, analyzing utility bills, calculating percentages during sales, or comparing product prices. The sessions should be structured so that participants can immediately apply their newfound knowledge to daily life, making learning more engaging and valuable.

In summary, the experiences from educational workshops for seniors reveal that participants are more inclined to engage in learning when the material is practical and directly relevant to their daily problems and challenges. Seniors who see real value in what they are learning are more motivated to participate in classes. Mathematics, when connected to practical topics like calculating living costs, savings, or understanding commercial offers, becomes more understandable and appealing to them. Therefore, it is beneficial to focus on content that helps seniors address real-life issues, as this not only enhances engagement but also promotes long-term learning effectiveness. When seniors recognize how newly acquired skills can improve their quality of life—both financially and ecologically—their motivation to learn increases significantly.

Another key takeaway is the need for flexibility in teaching and patience from educators. Adapting the learning pace to meet individual needs is crucial to the success of the entire educational process.

Seniors are a group with diverse life experiences and varying levels of mathematical skills, so educators should be prepared to adapt teaching methods to individual needs, allowing each participant to work at their own pace. Educators need to be patient and ready to spend more time on certain topics, as some concepts may require additional explanation to be fully understood. Patience, empathy, and flexibility are essential qualities for creating a learning environment that fosters skill development and the acquisition of new knowledge.

It's also important to recognize the value of using supportive learning tools. Adapting tools to meet the specific needs of seniors—such as calculators with large buttons and educational materials in both paper and digital formats—is crucial for ensuring comfort in learning. Seniors with vision impairments or manual challenges should have access to tools that facilitate calculations and problem-solving, making the learning process more accessible and enjoyable.

We encourage the use of our developed lesson plans, which can be valuable for conducting educational workshops with seniors. Our lesson plans incorporate proven teaching methods grounded in a practical approach, connecting mathematics with the everyday issues seniors face. These materials allow educators to tailor the workshop program to meet the individual needs of participants, taking into account the diversity in mathematical skill levels and learning pace. By using our lesson plans, educators can provide appropriate support, help seniors develop their mathematical skills, and raise their ecological awareness, ultimately enhancing the quality of life for seniors.

We recognize the importance of adapting education to the needs of seniors, which is why our plans include both mathematical and ecological elements, forming an ideal foundation for building knowledge in a practical and accessible way. These resources enable educators to fully harness the potential of their participants and help them develop skills that will have a real impact on their everyday lives.

If you have any suggestions regarding our work, we warmly invite you to reach out:

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