

Małgorzata Krzeczowska

Mathematics in an interdisciplinary project: “About science in a popular way”

Teaching natural subjects is much more difficult compared to other school subjects because students usually do not like chemistry, physics, or mathematics, considering these subjects difficult and completely unnecessary. Unfortunately, this is not a stereotype.

Teaching science subjects is related to shaping the student's research attitude, which is reflected in the general requirements included in the Polish core curriculum for general education¹.

Teaching by doing, researching, conducting experiments, planning experiments is the way to guarantee the effectiveness of the teaching and learning process. Many interesting chemical experiments can be carried out using substances known from everyday life and present in our homes. As teachers, however, we must draw students' attention to two important issues: safety and how to deal with the leftovers (waste) from the experiments performed. Search methods in teaching are, however, universal methods, regardless of the school subject taught or the level of education, and their effectiveness is confirmed by numerous scientific studies.

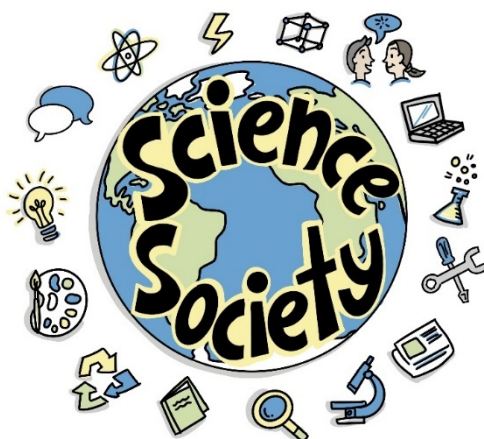
The STEAM methodology, which has been known since the 1990s, has taken on a slightly different meaning today (1); the same is true of the IBSE (Enquiry Based Science Education) methodology. Do the elements of this methodology used in school practice have to use the achievements of technology and transfer students to the virtual world?

Today, teachers must be even more aware of the significant role of cross-curricular correlation. Successful teaching of, for example, chemistry depends to a large extent on students' mathematical skills. Mathematics, the Queen of Sciences? Definitely yes. Without a doubt, it is a universal language to describe the world. Numbers, percentages, and mathematical operations are present in our daily life. Mathematical knowledge is essential to move freely in the modern world full of technology. It is good that there are teachers who teach in the right way and show how to use mathematical knowledge; which greatly facilitates the life and development and perhaps the future career of a young person.

¹<https://podstawaprogramowa.pl/>

Interdisciplinarity as a value of mathematics is the basis for the project activities “About science in a popular way” implemented since December 2021 at the Faculty of Chemistry of the Jagiellonian University in Krakow. The project is implemented with funds allocated to the Jagiellonian University by the Minister of Education and Science, under the Social Responsibility of Science program / Name and module of the application: Social responsibility of science – Popularization of science and promotion of sport.

Showing the “human face” of science is very important in building trust in it; it is science and its achievements that help us understand how the world around us works (graph below):



The main objective of the project is to disseminate science knowledge among students of grades 7 and 8 of primary school and grades 1 and 2 of secondary school, development of interest in science subjects by involving school students in the active use of prepared teaching materials on various interdisciplinary science issues:

1. *Colours of chemistry, that is, coloured substances in everyday life.*
2. *Chemical or ecological household cleaning.*
3. *Extraordinary features of ordinary water.*
4. *Air in the lead role.*
5. *Ad- or ab-? Or maybe just sorption?*
6. *Crime riddles... for a chemist.*
7. *Fast, faster or maybe slower?*
8. *Ecological alarm – Chemical and ecological rescue services in action.*
9. *Traces that can be seen and those that are not.*
10. *What is in a home first aid kit?*

Mathematics in an interdisciplinary project: “About science in a popular way” [197]

Educators have been using game and gamification methods in the educational process for decades, although, of course, they did not call it that. Games have great potential: safe environments, healthy competitions, commitment building, teamwork, achieving something, and above all learning through experience. As is well known, we remember best and longest what we do ourselves, what we experience ourselves.

As part of the project, board games and e-books are created. Questions in games take a variety of forms; some tasks directly test knowledge of a given topic; some are related to, for example, conducting simple and safe experiments; others with the performance of appropriate mathematical calculations, transformations of formulas and units. The prepared didactic materials are publicly available and free of charge (<https://www.facebook.com/people/0-nauce-w-spos6b-popularny/100088511139568/>). Project activities not only promote the natural sciences, but also provide interesting, fundamentally correct and reviewed educational materials for teachers, students, animators, educators, and anyone interested in science.

Sample tasks from chosen e-books:

Topic: *Crime riddles... for a chemist.*

Task: The term “lethal dose” (LD) refers to the amount of a given substance, expressed in units of mass, per 1 kg of body weight, which causes the death of an organism after a single administration. One of the macronutrients that performs important functions in the body is potassium. Sources of potassium include bananas. Estimate how many bananas with an average weight of 120 g would have to be eaten by a man weighing 75 kg, if it is known that in the case of a human, the lethal dose of potassium is 2600 mg/kg of body weight, and one banana contains about 400 mg of potassium.

Answer: 480 bananas.

Some comments:

This type of task requires the solver to carefully analyse the content; develops the ability to read with comprehension and the proper use of this information. Solving such a computational task forces the use of an appropriate plan - thoughtless application of learnt algorithms, where it will certainly not be applicable.

Topic: *Fast, faster, or maybe slower?*

2. The average flight time between London and New York is currently just over 8 hours. Concorde - a supersonic plane, operating on the same route, covered it incomparably faster. What was the average flight time of the Concorde on the London-New York route if it covered the distance of 5,587.49 km at a cruising speed of 2,158 km/h? Assume that it took a total of one hour to reach cruising speed after take-off and to brake for landing.

Answer: about 3.5 hours (the fastest flight was 2 hours and 53 minutes)

Some comments:

The content of the task tangibly shows the relationship between science and everyday life. In addition – which is very valuable for students from the perspective of external exams (mathematics) – the solver uses basic mathematical operations, showing the ubiquitous mathematics around us.

Topic: *Extraordinary features of ordinary water.*

3. Calculate the number of moles of molecules and the number of water molecules that a 59 kg person contains, assuming that 61% of his body weight is water.

Sample solution:

61% of 59 kg = 36 kg (water mass in the body)

18 g of H₂O – 1 mole of H₂O molecules

36,0·10³ g – x, x = 2000 moles of H₂O molecules

1 mole – 6,02·10²³ H₂O molecules

2000 moles – y; y = 1,2·10²⁷ H₂O molecules

Some comments:

Simple mathematical operations will allow the person solving the task to determine the amount of water, e.g. in his body. Once again in the task we see the direct application of mathematics in everyday life; showing the ubiquitous mathematics around us.

Interesting home experiment is presented here:

<https://thestemlaboratory.com/oil-ice-density-experiment/>

<https://www.instructables.com/Oil-and-Ice-Density-Experiment/>

Chemistry and other natural subjects are a field of science with which we come into contact in all spheres of life. So why do we often hear from students the question – why do we need this? Why are we learning this? Teachers share their fascination with chemistry, biology, physics, and mathematics with students, showing that these contents are present in our daily life. Let us teach conscious search and observation around chemical, physical, and biological processes; preferably using all the senses. These objects hide many secrets and curiosities that are worth exploring in order to become aware of the phenomena and processes in the world around us.

Three more e-books will be released in the near future:



All already prepared materials, can be downloaded from the Facebook page:

<https://www.facebook.com/profile.php?id=100088511139568>

or website: <https://chemia.uj.edu.pl/oferta/projekty-edukacyjne>



W ramach programu „Społeczna odpowiedzialność nauki” „Płatne ze środków Ministerstwa Edukacji i Nauki” na podstawie umowy nr SOW/SP/516547/2021 z dnia 14. lutego 2022; nazwa projektu: „O naukę w sposób popularny...”; kwota środków 30 000 zł.”



Mathematics in an interdisciplinary project: "About science in a popular way" [199]

Project activities are a lot of work, emotions, and efforts that I hope users will appreciate during the game, when searching for answers to questions or making simple experiments.

The graphics were made by *SiatArt*.

References

Jordan, Ch., Murillo-Arcila, M., Torregrosa, J.R.: 2021, *The STEM Methodology and Graph Theory: Some Practical Examples*, *Mathematics*, 9(23), 3110; <https://doi.org/10.3390/math9233110>

Malgorzata Krzeczowska
Faculty of Chemistry
Jagiellonian University in Kraków
e-mail: malgorzata.krzeczowska@uj.edu.pl