Pythagoras
2021-1-RO01-KA220-HED-000032258

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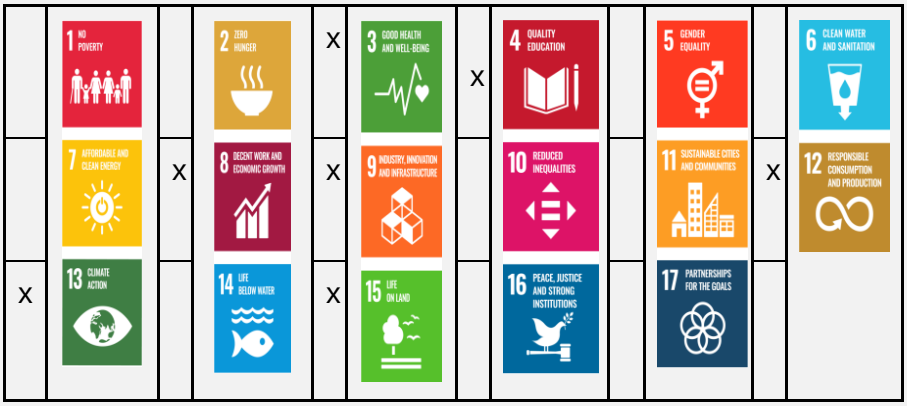
Mini-PBL example

Teaching Guide for Teachers

Mini-PBL project	
Teacher data sheet: Teaching Guide	
Title	Ecological textile printing GOTS
SDG attended	Using this UN graphics, we mark such SDG which this project works. 
Content units	Systems of linear equations
Sessions	2 sessions of 100 min
Hours of autonomous work	20 min
Competences to be developed	**Reasoning and modelling** • Develop thinking strategies to solve real life problems • Explore, analyse, and apply mathematical ideas • Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about graphs • Model with mathematics in situational contexts • Think creatively and with curiosity and wonder when exploring problems **Understanding and solving** • Develop, demonstrate, and apply conceptual understanding of mathematical ideas through story, inquiry, and problem solving • Visualize to explore and illustrate mathematical concepts and relationships • Apply flexible and strategic approaches to solve problems

<table>
<tr><td></td><td>

Solve problems with persistence and a positive disposition
Engage in problem-solving experiences connected with real-life examples.

Communicating and representing

Explain and justify mathematical ideas and decisions in many ways
Represent mathematical ideas in concrete, pictorial, and symbolic forms
Use mathematical vocabulary and language to contribute to discussions in the classroom
Take risks when offering ideas in classroom discourse

Connecting and reflecting

Reflect on mathematical thinking
Connect mathematical concepts with each other, other areas, and personal interests
Use mistakes as opportunities to advance learning
Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts

</td></tr>
<tr><td>ICT tools to be used</td><td>Free choice</td></tr>
<tr><td>Context: project statement</td><td>The production of waste is increasing with the speed directly proportional to its quantity, due to increasing industrial production and poor environmental measures. To decrease the waste accumulation it is necessary to adopt various ecological measures, as recycling of the produced waste, decrease in the production leading to the decreased speed of its accumulation and decrease of its growth acceleration. These adopted environmental measures cannot lead to the complete diminishing of the accumulated waste on the planet, but they can considerably improve the planet pollution and have beneficial effect on the climate changes.</td></tr>
<tr><td>Tasks and problems</td><td>The Slovak company MERCHYOU is one of the first European textile printing companies using only eco-friendly inks that do not contain heavy metals or phthalates. It is the first Slovak company and at the same time the only one in Slovakia, which offers ecological GOTS (Global Organic Textile Standard) certified imprint for t-shirt and other textile items.
Company uses textile screen printing, digital textile printing and hybrid printing to print these products: t-shirts, hoodies and trousers. (Adopted from https://www.merchyou.com/sk, 2023)
Production time in minutes [min] of above mentioned articles by using every type of printing is presented in the next table. (The data were provided by the company MERCHYOU.)
<table>
<tr><th rowspan="2">sort of printing</th><th colspan="4">the production time [min]</th></tr>
<tr><th>t-shirt (1 piece)</th><th>hoodie (1 piece)</th><th>trousers (1 piece)</th><th>maximal weekly capacity</th></tr>
<tr><td>screen</td><td>0,36</td><td>0,48</td><td>0,44</td><td>13 150</td></tr>
<tr><td>digital</td><td>1,81</td><td>2,42</td><td>2,18</td><td>13 169</td></tr>
<tr><td>hybrid</td><td>0,48</td><td>0,62</td><td>0,53</td><td>13 130</td></tr>
</table>
</td></tr>
</table>

Additional information about the number of produced articles:

- the number of t-shirts printed using digital printing is 5–times smaller than the number of t-shirts printed by screen printing
- the number of t-shirts printed using hybrid printing is only ¾ of the number of t-shirts printed by screen printing
- the number of hoodies printed using screen printing is 5–times greater than the number of hoodies printed by digital printing
- the number of hoodies printed using hybrid printing is 4–times greater than the number of hoodies printed by digital printing
- the number of trousers printed using screen printing is 1.25–times greater than the number of trousers printed by hybrid printing
- the number of trousers printed using digital printing is 4–times smaller than the number of trousers printed by hybrid printing.

Task

How many t-shirts, hoodies and trousers are produced in the company MERCHYOU weekly, if the time capacity of each sort of printing is fully utilised?

Solution:

Let be denoted: x – the number of t-shirts printed by screen printing

y – the number of hoodies printed by digital printing

z – the number of trousers printed by hybrid printing

$$\left.\begin{array}{rrrr} 0,36x + & 0,48\cdot 5y + & 0,44\cdot 1,25z = & 13150 \\ 1,81\cdot\frac{1}{5}x + & 2,42y + & 2,18\cdot\frac{1}{4}z = & 13169 \\ 0,48\cdot\frac{3}{4}x + & 0,62\cdot 4y + & 0,53z = & 13130 \end{array}\right\} \Leftrightarrow \begin{pmatrix} 0,360 & 2,40 & 0,550 \\ 0,362 & 2,42 & 0,545 \\ 0,360 & 2,48 & 0,530 \end{pmatrix}\cdot\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 13150 \\ 13169 \\ 13130 \end{pmatrix}$$

$$\left(\begin{array}{ccc|c} 0,360 & 2,40 & 0,550 & 13150 \\ 0,362 & 2,42 & 0,545 & 13169 \\ 0,360 & 2,48 & 0,530 & 13130 \end{array}\right) \sim \left(\begin{array}{ccc|c} 0,362 & 2,42 & 0,545 & 13169 \\ 0,360 & 2,40 & 0,550 & 13150 \\ 0,360 & 2,48 & 0,530 & 13130 \end{array}\right) \sim \ldots$$

$$\ldots \sim \left(\begin{array}{ccc|c} 1 & 10 & -2,50 & 9500 \\ 0 & 1 & -0,25 & -250 \\ 0 & 0 & 1,15 & 9430 \end{array}\right) \Rightarrow \begin{pmatrix} x = 12000 \\ y = 1800 \\ z = 8200 \end{pmatrix}$$

<table>
<tr><td></td><td>
<table>
<tr><th rowspan="2">the sort of printing</th><th colspan="3">the weekly production</th></tr>
<tr><th>t-shirts</th><th>hoodies</th><th>trousers</th></tr>
<tr><td>screen</td><td>12 000</td><td>9000</td><td>10 250</td></tr>
<tr><td>digital</td><td>2400</td><td>1800</td><td>2050</td></tr>
<tr><td>hybrid</td><td>9000</td><td>7200</td><td>8200</td></tr>
<tr><td>total</td><td>23 400</td><td>18 000</td><td>20 500</td></tr>
</table>
</td></tr>
<tr><td>Outcomes expected</td><td>- Numerical results explained and put in context;
- Capture of ICT tools solutions used;
- Sequence of steps followed;
- Remark computations done by hand and done by ICT tools;
- Provide complete answer to questions;
- All the results must be presented in the context of the problem;</td></tr>
<tr><td>Guide for Learning</td><td>At the beginning of the course, the students need guides on new activities, and feel your support on a well-structured pack of suggestions on how to address the posted problems. Namely:
- Read carefully the problem statement and the tasks posted. Always maintain a global view of all the projects.
- Identify, or try to do a first draft match, the content units of your lecture notes involved in every task.
- Take your lecture notes open and review before starting to solve the problems.
- Match output expected with the tasks posted, at least as first draft approach.
- Follow the order of the tasks, try to increase the knowledge of the problem while you are solving the activities.
- Always think that maybe there are different ways to solve a problem.
- Use ICT tools to avoid hard computations and check your solutions are correct in different ways if possible.
- The solutions are always part of a context, expressing such a final solution totally integrated in the problem posted.
- Be sure you answer the complete questions.
- Always try to solve the questions by yourself.
- If the project can be done in groups, discuss with the groups the proposed problem, to confirm and detect fails or weaknesses, confront strategies, discuss presentation format, etc. Working in groups doesn’t mean work less but work better.</td></tr>
</table>

Guide for Teaching	Some hints needed to present and launch the mini-PBL to students - Do a small Introduction concerning the Climate Change crisis we are currently living in. - Do a small introduction about the relations between accumulated waste on the planet, while environmental measures, decrease in the production and usage of eco-friendly materials can considerably improve the planet pollution. - Students will form groups of 4 students and solve the mini-PBL using the eduScrum methodology. - The students should do each exercise in a sequential order, starting from Task 1. - The students should be able to thoroughly read and interpret the numerical results from a mathematical and the real-life example point of view. They should include also a discussion of the climate change crisis and enumerate some strategies they could apply at home or even at university to save resources, namely reduce energy consumption. They should also mention how this mini-PBL helps them identify the indicated Sustainable Development Goals.
Assessment	- Final report; - Oral presentation; - Peer-assessment: students will apply peer-assessment for their periodic performance using online peer assessment tools used and available at the respective institution.
Others: References	The task was created by Institute Mathematics and Physics of FME STU in Bratislava in cooperation with the company MERCHYOU, Slovakia, 2023.

Learning Guide for Students

Mini-PBL project	
Student data sheet: Teaching Guide	
Title	Ecological textile printing GOTS

SDG attended	Using this UN graphics, we mark such SDG which this project works. 
Content units	Systems of linear equations
Sessions	2 sessions of 100 min
Hours of autonomous work	20 min
ICT tools to be used	Free choice
Context: project statement	The production of waste is increasing with the speed directly proportional to its quantity, due to increasing industrial production and poor environmental measures. To decrease the waste accumulation it is necessary to adopt various ecological measures, as recycling of the produced waste, decrease in the production leading to the decreased speed of its accumulation and decrease of its growth acceleration. These adopted environmental measures cannot lead to the complete diminishing of the accumulated waste on the planet, but they can considerably improve the planet pollution and have beneficial effect on the climate changes.
Tasks and problems	The Slovak company MERCHYOU is one of the first European textile printing companies using only eco-friendly inks that do not contain heavy metals or phthalates. It is the first Slovak company and at the same time the only one in Slovakia, which offers ecological GOTS (Global Organic Textile Standard) certified imprint for t-shirt and other textile items. Company uses textile screen printing, digital textile printing and hybrid printing to print these products: t-shirts, hoodies and trousers. (Adopted from https://www.merchyou.com/sk, 2023) Production time in minutes [min] of above mentioned articles by using every type of printing is presented in the next table. (The data were provided by the company MERCHYOU.)

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Outcomes expected	- Numerical results explained and put in context; - Capture of ICT tools solutions used; - Sequence of steps followed; - Remark computations done by hand and done by ICT tools; - Provide complete answer to questions; - All the results must be presented in the context of the problem;
Guide for Learning	- Read carefully the problem statement and the tasks posted. Always maintain a global view of all the projects. - Identify, or try to do a first draft match, the content units of your lecture notes involved in every task. - Take your lecture notes open and review before starting to solve the problems. - Match output expected with the tasks posted, at least as first draft approach. - Follow the order of the tasks, try to increase the knowledge of the problem while you are solving the activities. - Always think that maybe there are different ways to solve a problem. - Use ICT tools to avoid hard computations and check your solutions are correct in different ways if possible. - The solutions are always part of a context, expressing such a

	final solution totally integrated in the problem posted. - Be sure you answer the complete questions. - Always try to solve the questions by yourself. - If the project can be done in groups, discuss with the groups the proposed problem, to confirm and detect fails or weaknesses, confront strategies, discuss presentation format, etc. Working in groups doesn't mean work less but work better.
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ANNEX 1: RUBRIC

Category	4=Excellent	3=Good	2=Low	1=Poor
Mathematical Concepts	Explanation shows complete understan- ding of the mathe- matical concepts used to solve the problem(s).	Explanation shows substantial understan- ding of the mathema- tical concepts used to solve the problem(s).	Explanation shows some understan- ding of the mathe- matical concepts needed to solve the problem(s).	Explanation shows very limited unders- tanding of the underlying concepts needed to solve the problem(s) OR is not written.
Mathematical Terminology and Notation	Correct terminology and notation are always used, making it easy to understand what was done.	Correct terminology and notation are usually used, making it fairly easy to understand what was done.	Correct terminolo- gy and notation are used, but it is sometimes not easy to understand what was done.	There is little use, or a lot of inappropriate use, of terminology and notation.
Strategy/Procedure	Typically, uses an efficient and effective strategy to solve the problem(s).	Typically, uses an effective strategy to solve the problem(s).	Sometimes uses an effective strategy to solve problems, but does not do it consistently.	Rarely uses an effective strategy to solve problems.
Completion	All problems are completed.	All but one of the problems are completed.	All but two of the problems are completed.	Several of the problems are not completed.
Mathematical Errors	90-100% of the steps and solutions have no mathematical errors.	Almost all (85-89%) of the steps and solu- tions have no mathematical errors.	Most (75-84%) of the steps and solu- tions have no mathematical errors.	More than 75% of the steps and solu- tions have mathe- matical errors.

Sources Checking				
Working with Others	Student was an engaged partner, listening to suggestions of others and working cooperatively throughout lesson.	Student was an engaged partner but had trouble listening to others and/or working cooperatively.	Student cooperated with others, but needed prompting to stay on-task.	Student did not work effectively with others.
Neatness and Organization	The work is presented in a neat, clear, organized fashion that is easy to read.	The work is presented in a neat and organized fashion that is usually easy to read.	The work is presented in an organized fashion but may be hard to read at times.	The work appears sloppy and unorganized. It is hard to know what information goes together.
Diagrams and Sketches	Diagrams and/or sketches are clear and greatly add to the reader's understanding of the procedure(s).	Diagrams and/or sketches are clear and easy to understand.	The work is presented in an organized fashion but may be hard to read at times.	Diagrams and/or sketches are difficult to understand or are not used.
CT tools used				