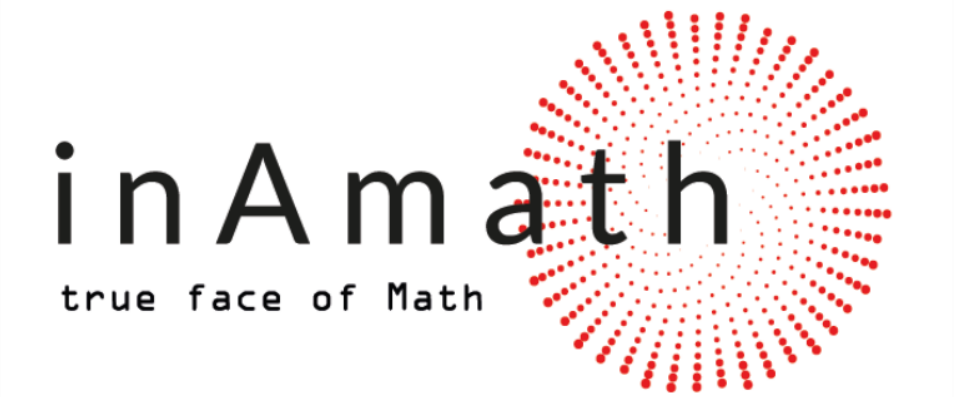


An interdisciplinary approach to mathematical education

SCENARIOS FOR SPECIAL DAYS

The content of scenarios is designed and created within the Erasmus+ project:

InAMath - An interdisciplinary approach to mathematical education

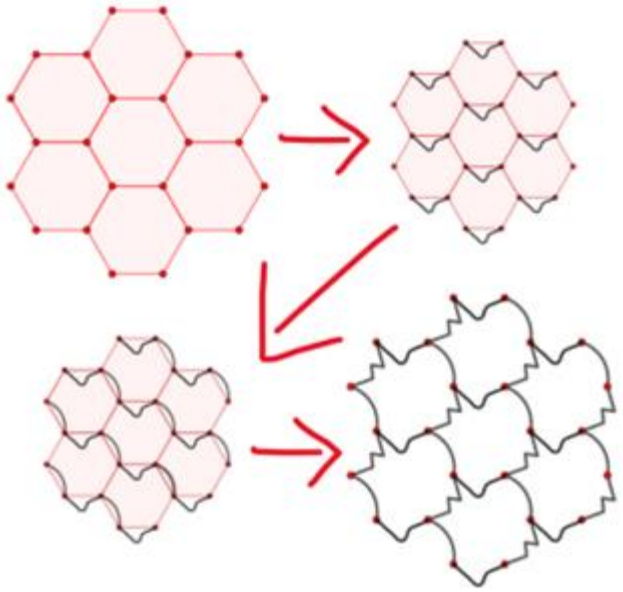
The project An interdisciplinary approach to mathematical education (2020-1-HR01-KA201-077816) is co-founded by the Erasmus+ Programme of the European Union, Key Action: Cooperation for innovation and the exchange of good practices - Strategic Partnerships for school education.

Contents

Title	Math Board Game Day: Mathematics in other words
Keywords	Mathematics, game, gamification
Short description	Gamification is the application of games or elements of play in situations that are not exclusively related to the game, with the aim of increasing motivation and concentration. In the lower grades of elementary school, children's play is a natural and acceptable environment in which they feel comfortable. Many learning outcomes can be achieved partially or completely through play. This activity describes how to learn the definitions of mathematical terms appropriate to lower grades of elementary school using the game.
Included ICT tools	3d modeling
Objective of the activity	Learning the definitions of mathematical concepts and distinguishing mathematical concepts using the game.
Expected duration of activity	60 minutes
Preparation of activities	1. It is necessary to print and cut the cards (if you are able to laminate the cards, they will last longer and will be less damaged through use)- Each card contains 5 mathematical terms that students know, so that in the first line there is a term from the 1st grade, then a term from the 2nd grade, 3rd grade and 4th grade. In fifth place can be a term from any class. 2. It is necessary to print the playing board on A4 paper (or larger). 3. It is necessary to prepare 6 different figurines for playing (https://www.tinkercad.com/things/IDMysOiePu2-game-figure). 4. Hourglass or stopwatch. 5. Prepare instructions for playing. All materials are available on: https://inamath.uniri.hr/mathematical-alias/
Detailed description of activities	A minimum of 4 and a maximum of 12 students (divided into pairs) can play on one playing board. Each pair chooses their own figurine. One team draws a card with terms, and the other team chooses a number from 1 to 5. The first pair starts with the game, the hourglass is turned/the stopwatch is started (for example 1 min). One player in a pair turns cards from the deck in a row and explains to the other player the term that is under the selected number. The other player needs to guess the term written on the card. It is forbidden to use the same root of the word. Synonyms and similar terms can be used. Other players keep track of the time and when the hourglass/stopwatch expires, the player's move is over. Players move as many places as the terms guessed. The game continues with the second pair. When it's the first pair's turn again, it guesses the terms from the card depending on the number he stepped on with the pawn on the board. The winner is the couple who reaches the finish line first. Before starting the game, participants (or teacher) should determine one of the following variants of the game being played.

	1. Easier variant: no "negative points". If a player does not know how to explain the term from the card, they can skip it and draw a new card. After the time has elapsed, only the guessed terms are counted and the figurine moves for the number of places equal to the number of guessed terms. 2. Challenging variant 1: no "negative points", no skipping cards. If a player does not know how to explain the term from the card, he must not skip the drawn term, but must make an extra effort or wait for the end of time. After the time has elapsed, only the guessed terms are counted and the figurine moves for the number of places equal to the number of guessed terms. 3. Challenging variant 2: with "negative points". If a player does not know how to explain the term from the card, he can skip that term and draw a new card, but with a penalty point (per card). The cards that are guessed are placed on one pile and skipped cards on another pile. After the time has elapsed, the difference is calculated: the number of guessed terms minus the number of skipped cards and the figurine moves by the corresponding number of places. If there are more skipped cards than the guessed terms, the figurine remains in the same place. 4. A variant that includes a foreign language a. After the student reads the term in his native language, it should be translated into a foreign language and thus explained to his couple. A more advanced variant is that the student must explain the term in English (without using a direct translation of the term). b. After the student reads the term written in a foreign language, it should be translated into his native language and thus explained to his couple. A more advanced variant is that the student must explain the term in his or her native language (without using a direct translation of the term).
Possibility to expand activities	• Cards for primary school students (English) • Cards for students of higher grades of primary school (Croatian language) • Link to cards for high school students (Croatian language) • Link to cards for mathematics students (Croatian language) • Storytelling game with Story Platonic solids (scenario Describe and place me!)
Additional notes	
Authors	Bojan Crnković, Vedrana Mikulić Crnković, Ivona Traunkar (Faculty of Mathematics, University of Rijeka)

Title	# Mathematical exhibition: Archimedes meets Escher
Keywords	mathematical exhibition, tiling the plane, polygons
Kratki opis	A mathematical exhibition is an excellent way of presenting mathematical content and, by mixing art and mathematics, we present mathematical concepts in a completely different way. A mathematical exhibition in which students participate in all the steps of designing, creating, organizing and implementing the exhibition is an excellent, inclusive, creative and fun way of learning mathematics and acquiring mathematical concepts and terms.
Included ICT tools	GeoGebra, 3d modeling
Objective of the activity	The aim of the activity is to create and conduct a mathematical exhibition on the theme of tiling the plane with a group of students. Students participate in all phases of the activity and in the final stage prepare and exhibit their works.
Expected duration of activity	270 minuta (aktivnost potiče kreativnost učenike te je moguće da izrada eksponata traje dulje od predviđenog vremena)
Priprema aktivnosti	1. Modelling clay 2. GeoGebra file showing the transformation of Archimedes tiles into Escher tiles 3. A3 paper, crayons, laminator
Detailed description of the activities	1. step (45 minutes): introduction to the theme of the exhibition In this activity, we introduced students to the topic of the exhibition through the activities described in the scenario Mathematical puzzle. 2. step (180 minutes): creation of exhibits (the activity encourages the creativity of students and it is possible that the creation of exhibits takes longer than the estimated time) As part of this exhibition, we have created exhibits through several phases. a. Making "tiles" in GeoGebra • After the students are introduced to the regular and Archimedes tilings, students in GeoGebra draw some regular (square and regular hexagon) and Archimedes paving in GeoGebra (e.g. (4,8,8,8) tiling). • They transform drawn pavings by obtaining unique so-called Escher tiles from them. In the following image we illustrate the transformation process in one example (https://www.geogebra.org/classic/rgcxbypx)

	 b. The use of made tiles for the manufacture of exhibits • The teacher prints out his "tiles" to each student on paper. The student cuts the "tiles" and paves A3 paper with them, which he then decorates. It is desirable that the teacher laminate the student's works that will be exhibited. • The teacher exports the STL file from the created Geogebra files of the student and with the help of a 3d printer prints molds of "tiles" that the students have made. Note: This step is more technically demanding and teachers should help students in exporting an STL document (set parameters). If possible, it is desirable to show students how the 3d molds are printed and introduce them to 3d printing technology. Using made molds, students make their "tiles" from modelling clay. Note: Instead of molds printed on a 3d printer, the teacher can print or paste students' "tiles" on a thicker paper and the student can carve modelling clay according to the made "tile". Tiles are used to pave the plane, and then each can be decorated as desired. 1. step (45 minutes): setting up the exhibition Students prepare papers with their names, exhibition title and place their paintings and arrange their tiles made with clay.
Possibility to expand activities	Although this scenario describes a mathematical exhibition on the theme of plane paving, the steps of implementing the activity can also be applied in the case of some other topic. A mathematical exhibition can be created on many topics. It is desirable, as more as possible, to involve students in the design of the topic and to take into account their ideas and interests. Furthermore, a mathematical exhibition is an excellent way of realizing an interdisciplinary approach to teaching that can, in addition to mathematics, include the use of digital tools, the use of techniques of artistic expression, research work that

	connects mathematics with content from nature (short stories from history, specifics of an area, etc.). Within this project, we have created several more mathematical exhibitions, on a larger or smaller scale, on the following topics: Perspective drawing Drawing with symmetries Taxi geometry We also supplemented the activity by creating a virtual tour of the exhibition. We called the exhibition Archimedes meets Escher and it was set up as part of the program of the Rijeka Festival znanosti 2022. After the opening, we recorded the exhibition with 360° camera and subsequently created a virtual tour with the students with the help of free tools (one example of a virtual tour can be found at https://orbix360.com/ALxmV99L2. The described activity did not include the design and implementation of the exhibition management, which is certainly a welcome addition in which students can contribute a lot and learn. Within the project, articles were published describing the steps in organizing the mathematical exhibition: "How to organize a mathematical exhibition – taxi geometry" (Vedrana Mikulić Crnković, Dina Mlacović, Marko Mrvoš)
Additional notes	
Authors	Bojan Crnković, Vedrana Mikulić Crnković, Ivona Traunkar (Faculty of Mathematics, University of Rijeka)

SCENARIO FOR MARKING SPECIAL DAYS	
Title	# A day in the Pi rhythm
Keywords	Number Pi
Short description	In the scenario, we describe several activities through which pi day can be marked with students through play and fun (14.3.). When designing the activities, we took care to design activities for all ages, to make the activities fun and that they can be performed in different spaces.
Included ICT tools	micro:bit, micro:macqueen, mBot, GeoGebra, FSM Logo
Objective of the activity	Mark Pi Day through various creative activities and thus connect mathematics with play. Although it is difficult for students of younger ages to define an infinite non-periodic decimal number, through story and play to show them the peculiarities and characteristics of number pi.
Expected duration of activity	The duration of the activity depends on the number of activities.
Preparation of activities	Code files: 1. Code file Micro:bit: Clicking B prints the following digit; clicking on A+B shows how many digits are displayed from https://inamath.uniri.hr/pi-dan/ you need to download the file *microbit-pi_digits-3.hex* 2. Code file to control micro:macqeen using micro:bit for driveing in Py rhythm, all codes can be downloaded from https://inamath.uniri.hr/pi-dan/ a. Automatic driving you need to download file *microbit-pi_digits_forever-2.hex* b. The microbit runs macqueen you need to download file *microbit-maqueen_pi.hex* (code file for microbit for macqueen) and *microbit-pi_digits_on_button_b.hex* (code for microbit) 3. Code file for micro:bit communication with the goal of counting certain digit. From https://inamath.uniri.hr/pi-dan/ you need to download the following files: *microbit-pi_digits_forever-2.hex, microbit-0-2.hex, microbit-1-2.hex, microbit-2-2.hex, microbit-3-2.hex, microbit-4-2.hex, microbit-5-2.hex, microbit-6-2.hex, microbit-7-2.hex, microbit-8-2.hex, microbit-9-2.hex.* Digits of Pi (first 300): • Ones digit: 3 • The first 299 digits in the decimal part of Pi: 1, 4, 1, 5, 9, 2, 6, 5, 3, 5, 8, 9, 7, 9, 3, 2, 3, 8, 4, 6, 2, 6, 4, 3, 3, 8, 3, 2, 7, 9, 5, 0, 2, 8, 8, 4, 1, 9, 7, 1, 6, 9, 3, 9, 9, 3, 7, 5, 1, 0, 5, 8, 2, 0, 9, 7, 4, 9, 4, 4, 5, 9, 2, 3, 0, 7, 8, 1, 6, 4, 0, 6, 2, 8, 6, 2, 0, 8, 9, 9, 8, 6, 2, 8, 0, 3, 4, 8, 2, 5, 3, 4, 2, 1, 1, 7, 0, 6, 7, 9, 8, 2, 1, 4, 8, 0, 8, 6, 5, 1, 3, 2, 8, 2, 3, 0, 6, 6, 4, 7, 0, 9, 3, 8, 4, 4, 6, 0, 9, 5, 5, 0, 5, 8, 2, 2, 3, 1, 7, 2, 5, 3, 5, 9, 4, 0, 8, 1, 2, 8, 4, 8, 1, 1, 1, 7, 4, 5, 0, 2, 8, 4, 1, 0, 2, 7, 0, 1, 9, 3, 8, 5, 2, 1, 1, 0, 5, 5, 5, 9, 6, 4, 4, 6, 2, 2, 9, 4, 8, 9, 5, 4, 9, 3, 0, 3, 8, 1, 9, 6, 4, 4, 2, 8, 8, 1, 0, 9, 7, 5, 6, 6, 5, 9, 3, 3, 4, 4, 6, 1, 2, 8, 4, 7, 5, 6, 4, 8, 2, 3, 3, 7, 8, 6, 7, 8, 3, 1, 6, 5, 2, 7, 1, 2, 0, 1, 9, 0, 9, 1, 4, 5, 6, 4, 8, 5, 6, 6, 9, 2, 3, 4, 6, 0, 3, 4, 8, 6, 1, 0, 4, 5, 4, 3, 2, 6, 6, 4, 8,

	2, 1, 3, 3, 9, 3, 6, 0, 7, 2, 6, 0, 2, 4, 9, 1, 4, 1, 2, 7 Prepare sheets with digits, sheets with rules, drawing papers, crayons...
Detailed description of activities	To begin with, we introduce students to the number Pi and to Pi day through a short story. The approximate value of Pi is 3.14 and 14.3. is marked Pi day. **The story of number Pi:** Pi is one special number, quite different from all other numbers. He's a completely irrational, yet positive character who has no end. It wanders in circles and, if you look carefully, you can find it in every circle. On the number line, his home is between the numbers 3 and 4, closer to number 3 than to number 4. Although it is sometimes difficult to write it down on a sheet of paper, you can have a lot of fun if you play the game in Pi rhythm. **1. <u>ACTIVITY: Driving in Pi rhythm</u>** Student make a program where the micro:macqueen automatically moves by reading pi digits from the list (including the unit digit and digits in the decimal part of the number) and behaving according to the rules given in the following table.

DIGIT	MOVEMENT	SOUND	LED	RGB LED
0,1	Step forward	Middle C	Left – on Right - on	blue
2,3,4	Step right	Middle D	Left – off Right - on	green
5,6	Step backwards	Middle E	Left – off Right - off	red
7, 8,9	Step left	Middle F	Left – off Right - on	yellow

2. <u>ACTIVITY: Count me in Pi rhythm</u>

The main micro:bit sends digits while the remaining 10 (who are in the same radio group) count each of their digits.
A similar counting activity can be done in another programming language (e.g., Scratch).

3. <u>ACTIVITY: Dance in Pi rhythm</u>

Each student receives a paper with printed digits of pi or micro:bit (the next digit pi appears by clicking the B button) and moves according to the rules in the Pi dance table.

PI DANCE	
DIGIT	RULE
0,1	Step forward
2,3,4	Step right
5,6	Step backwards
7, 8,9	Step left

4. <u>ACTIVITY: Game in Pi rhythm</u>

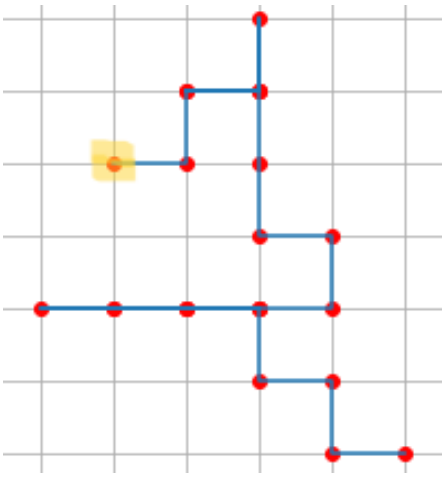
1. Game variant: The game is played in pairs. One member of the pair receives a paper (or micro:bit) containing the unit digit and the first 299 digits in the decimal part of pi. Students move according to the rules in the Pi dance table.
   Jedna partija igre traje 2 minute.
   Couples compete with each other. The winner is the one who takes the most accurate steps in the given time (we can find out the number of steps on the micro:bit by pressing A+B.
   One player is a referee who takes care that everything is regular.
2. Game variant: Each student plays for themselves in such a way that, with the help of the micro:bit, following digits of the number pi they guide macqueen or guide mBot according to the rules given in the table.
   If students use mBot (in addition to the initial program and the original remote) the rules can be:

DIGIT	RULE
0,1	Forward (two seconds)
2,3,4	Right (two seconds)
5,6	Backward (two seconds)
7, 8,9	Left (two seconds)

3. Game variant: Each student plays for themselves in such a way that, following digits of number that appear on the micro:bit at click, move according to the rules set in the table.

5. <u>ACTIVITY: Drawing in Pi rhythm</u>

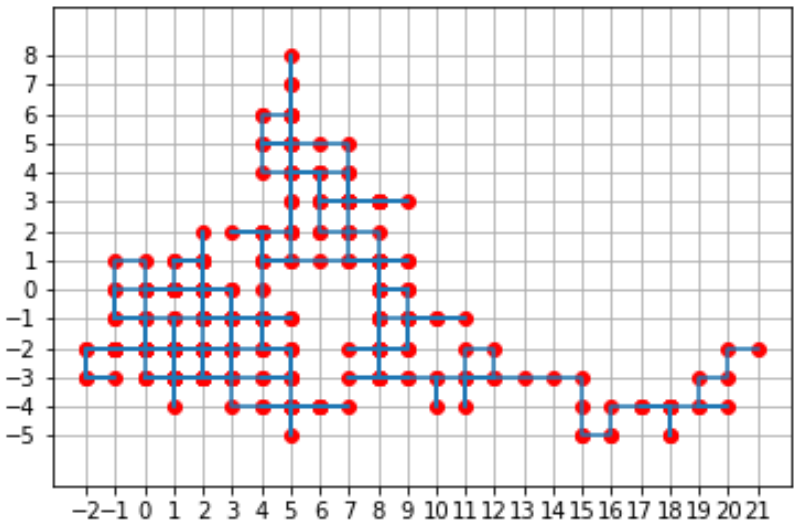
1. variant: A group of students of 4 students put a large (at least 1mx1.2m) piece of paper or cardboard on the floor on which they draw with their feet or palms (dipped in paint for drawing with their hands).
   Students draw alternately. The first student initially positions himself on a yellow field and, after 24 steps, the picture will look similar to the picture below. Students move according to the rule in the Pi dance table and leave a fingerprint with their hand or foot in such a way that their fingers indicate the direction they are moving.



Drawing can also be done as follows: students begin to put prints on the upper left corner and then to the right, or row by row, but when

leaving a fingerprint, they show the direction (from the Pi dance table) that corresponds to the digits of the number Pi.

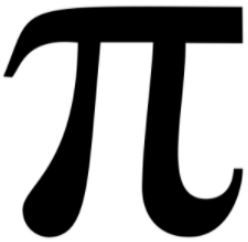
2. variant: This activity can also be carried out on A4 paper (https://inamath.uniri.hr/wp-content/uploads/2022/02/crtanje-u-pi-ritmu.pdf) on which the grid is highlighted (in this case we use the digit unit and the first 299 digits in the decimal part, and after so many steps the image should look like in the attachment).



variant: This activity can also be carried out using the FMS Logo program and GeoGebra (in these cases, the number of digits drawn may be higher).

Drawing number pi:

Students are given the task to draw the number Pi in the FMS Logo (either in GeoGebra or on paper) as best as possible (recognizing and drawing geometric shapes):



Students can draw or display pi with their bodies.

6. ACTIVITY: Coloring in Pi rhythm

Students are given the paper with squares or coloring books (attached to the document) and they paint the squares in order following the digits according to the rules in the pi color table.

PI COLOR	
DIGIT	COLOR
0	white
1	yellow
2	blue
3	red
4	green
5	orange
6	brown

		7	black	
		8	purple	
		9	pink	
Opportunities to expand activities	• The rules in the Pi dance table can be changed and adjusted. 1. For the rules in the Pi dance table, youcan change the number of steps in individual activities. If you want to see where the game ends in this case, watch the following video: https://youtu.be/51nvA_5z3T8 • In computer science class, any of the code files used tried in the activity can be done with students.			
Dodatne napomene				
Authors	1. Bojan Crnković, Vedrana Mikulić Crnković, Ivona Traunkar (Fakultet za matematiku, Sveučilište u Rijeci) 2. Loris Rašpolić (Centar tehničke kulture Rijeka)			

COLORING BOOK