

Europeana Learning Scenario

Title

Mathematical discoveries in Romanesque Architecture

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Abstract

Mathematics is everywhere in science, technology and art. It is a science of ideas and ideals.

This learning scenario will explore the mathematics present in Romanesque Architecture, with emphasis on the Route of the Romanesque, an historical route in northern Portugal. Students will be invited to learn more about the irrational number Pi (with a story and a video) and get to know Romanesque Architecture, focusing on its rosettes. These will lead to a better understanding of the symmetry of rotation and the formula for calculating the lateral surface of the cone of revolution. The use of the number Pi for the calculation of areas and perimeters of circles will be explored in general terms. Technology and gamification are present, to arouse interest, increase participation, develop creativity and autonomy, promote dialogue and solve problem situations.

Keywords

Pi, Romanesque, Tale, Composition, Gamification

Table of summary

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| Subject | Mathematics, History, Art and ICT |
| Topic | Number Pi and the area of the lateral surface of the cone for stamping a Romanesque Rosette |
| Age of students | 13-15 |
| Preparation time | 60 min |
| Teaching time | 130 mins |
| Online teaching material | <p>CultureMoves: https://portal.culturemoves.eu/noniusadventures/romanesque-math-discoveries</p> <p>where you can find:</p> <p>Europeana Collections: https://www.europeana.eu/portal/en</p> |

| | |
|---------------------------|---|
| | <p>Rota do Românico: https://www.rotadoromanico.com/en/</p> <p>Flipsnack: an irrational love story by noniusadventures</p> <p>TED Ed Movie: https://youtu.be/9a5vHXsUvUw</p> <p>Pi Day: http://mypiday.com/index.html</p> <p>Atractor (at imaginary.org): https://imaginary.org/fr/node/1073</p> <p>Kahoot: https://play.kahoot.it/v2/?quizId=e115842f-a3d9-4471-9d7c-795d702e4616</p> <p>Inspirograph: https://nathanfriend.io/inspirograph/</p> |
| Offline teaching material | <p>Paper; pencil; compass; ruler; schoolbook; mobile phone or tablet; interactive whiteboard; math tale printed (https://archive.org/details/pia3print)</p> |
| Europeana resources used | <p>Church from BL Add 39636 - Historiated initial 'T' of a Romanesque church with a rose window by a lake, measuring 100 x 115.</p> <p>Kompozíció - Picture of a house and church composed of Romanesque elements and a tree in front - linocut.</p> <p>San Zeno, Verona - View of the church of San Zeno in Verona showing the doorway, rose window, and parts of adjacent buildings.</p> <p>Spiel - Zeichenspiel : Spirograph.Familie : Frau & Mann & Mädchen & Junge & Spirograph</p> |

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Integration into the curriculum

The topic fits in the national curriculum of mathematics (9 grade), that requires the study of irrational numbers, like Pi, and the calculation of the lateral surface area of a cone.

As stated in the document of the Portuguese Ministry of Education *Essential learning - Articulation with the profile of students*, are purposes of mathematics teaching: “To promote the acquisition and development of knowledge and experience in Mathematics and the capacity of its application in mathematical and non-mathematical contexts. Develop positive attitudes towards mathematics and the ability to know how to value the cultural and social role of this science.”

Aim of the lesson

The aim of this lesson is to promote mathematics from a cultural and historical point of view, making the irrational number Pi better known and leading students to discover the formula of the lateral surface of the cone through a game. A relationship is established between various mathematical and non-mathematical subjects, creating a comprehensive perspective of the discipline.

Outcome of the lesson

Students will read, write, discuss ideas and results, play a game and investigate solutions with mobile technology and geometric design instruments. They will produce a written work and an artistic work with an online spirograph. Students will discuss different point of views during their presentations.

Trends

Collaborative learning: a strong focus on group work;

Peer Learning: students learn from peers and give each other feedback;

BYOD: Students bring their own mobile devices to the classroom;

Anchor Learning: a technology centered learning approach; activities are designed or tied around an "anchor", such as an adventure or story, with a problem at the end that needs to be resolved.

Search & Learning: Visual images and multimedia are more powerful than verbal stimuli.

21st century skills

Collaboration: by working in teams to write a Math Composition.

Creativity: by creating a Rosette using technology.

Communication: by discussing and presenting the work developed to their peers.

Critical Thinking: by analysing different ways to solve problems and proposing new ideas.

Digital Literacy: by using tools, like Kahoot or Inspirograph, and platforms such as Europeana, Rota do Românico, Atractor, TED Ed.

Activities

| Name of activity | Procedure | Time |
|---------------------------------------|--|--------|
| 1. Presentation | Using the scrapbook Romanesque Math Discoveries , present Romanesque Architecture (from Europeana Collections). Explain how to search for information on the Europeana portal. | 10 min |
| 2. The Route of the Romanesque | Show the video mapping The Route of the Romanesque , to promote curiosity for that Portuguese route. | 5 min |
| 3. A hidden number and | Individually (using the Flipsnack story) or in small groups (using the A3 story), students will read the mathematical tale presented, which will serve | |

| Name of activity | Procedure | Time |
|--|--|--------|
| a fun story | as a motto for the Pi number approach as an irrational number, quotient between the perimeter and the diameter of a circle, and its relation to the International Day of Mathematics. | 15 min |
| 4. The infinite life of... Pi | The TED Ed movie “The infinite life of... Pi” is presented for a better understanding of Pi and its importance in the world. The students are invited to use their mobile phones and search for their date of birth in the infinite decimal places of Pi. | 10 min |
| 5. Find Pi in Romanesque art | Now, in team work, students will look for the Monastery of the Saviour of Paço de Sousa and discover a beautiful rose window (rosette). The teacher should first explain what a mathematical rosette is and remember the kind of symmetry involved. | 10 min |
| 6. MathLapse Rosette | The students see on their devices the MathLapse that illustrates a process for constructing a stamp for imprinting a rosette which has (only) rotation symmetry. | 5 min |
| 7. Math challenge- The rosette | Each team plays a Kahoot challenge with the other teams, with moderation from the teacher. The wrong answers should be analyzed in small group and with the class, in order to achieve a better understanding of the subjects focused on the game. | 15 min |
| 8. Try a Math Composition | A math composition about the rosette at the Monastery of the Saviour of Paço de Sousa is proposed to each team. Students will be encouraged to relate various mathematical subjects, such as rotation symmetries, perimeters and areas of circles and circular sectors and calculation of lateral surfaces of cones, with concrete examples for application of the formula. Students will be free to put together elements they consider relevant and should present a geometrical construction of a mathematical rosette. | 30 min |
| 9. Presentation of the Math Composition | Each team will present the result of their work to all class. During the presentation the peers will evaluate the other teams work using the formative assessment “Two stars and a wish”. | 25 min |
| 10. Inspirograph yourself! | The spirograph is presented to the students from a Europeana image and is proposed to them the individual construction of a rosette with Inspirograph . At home, they will also respond to the Google Form Romanesque Math Discoveries in order to give their Lesson Feedback. | 5 min |

Assessment

[Assessment for learning \(AFL\)](#) is an approach to teaching and learning that creates feedback which is then used to improve students’ performance. Students become more involved in the learning process and from this gain confidence in what they are expected to learn and to what standard.

The **Math Challenge – The rosette** has its own assessment as a Kahoot game. The teacher can guide the discussion between students to understanding the issues, especially when they make mistakes in solving them.

Math Composition is an open question, where students will be free to choose the ideas to present, the best way to do so and to use their creativity and geometric design skills. In their presentation to the class, each group will be assessed by the other groups using the approach “**Two stars and a wish**”. Each star is a positive feedback and the wish is something that should be improved. This approach promotes a context of collaboration and positive feedback concerning the work done by the students.

The activity **Inspirograph Yourself** is a proposal for individual homework assignment. Each figure built will be shared online with students so that they can evaluate each other's work and help the teacher in the final evaluation. In case of positive evaluation, the work will be part of a mathematical rosette wall, to be shared on the school page.

***** AFTER IMPLEMENTATION *****

Student feedback

Students were invited to give the teacher a Lesson Feedback with the Google Form [Romanesque Math Discoveries](#). 85% of the students really liked the lesson and 15% liked it a lot. All considered that the relationship established between History and Mathematics was positive for a better understanding of the contents studied. Of the materials presented in the Scrapbook at Culture Moves Portal, the students found the following more interesting: Romanesque Architecture at Europeana; The Route of the Romanesque; A hidden number and a fun story; Find your Pi Day; the Math Challenge (with Kahoot) and Inspirograph Yourself. Everyone would like to have more of these lessons, and they even suggested one a month.

Teacher's remarks

This learning scenario can be adapted according to the available lesson time. For example, points 3 and 4 can be proposed for home in a previous lesson (as was the case with the implementation carried out). Students may be invited to summarize the Story and discuss the TED Ed video with their classmates.

In order to better understand each step of the game performed in Kahoot, the figures that appear in the game were analyzed with the students (which are listed in the Annex). Students reach the idea of the proportion that can be established between the areas and perimeters of the rosette and its circular sector that constitutes the lateral surface of the cone, paying special attention to the rays of both the rosette (identified with the letter g) and the base of the cone (identified with the letter r).

And, after the game, the teacher recapitulated the whole process, which facilitated the achievement of the mathematical composition proposed in point 8.

An example of the use of the spirograph and the difference between mathematical rosettes and non rosettes was made by a student and in class discussion.

The learning scenario was applied with students who first met the Europeana digital platform and who had never used the Kahoot and Inspirograph applications. Although they were students living in locations along the Romanesque Route, many were unaware of its main features and valued the relationship established with mathematics.

About the Europeana DSI-4 project

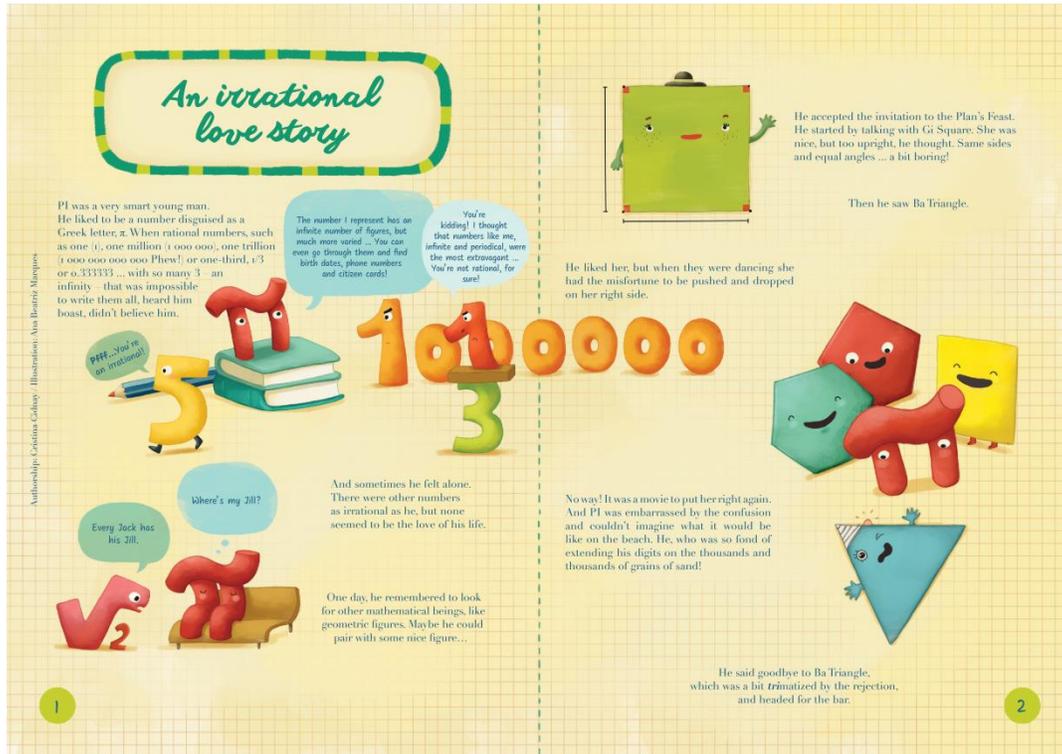
[Europeana](#) is Europe's digital platform for cultural heritage, providing free online access to over 53 million digitised items drawn from Europe's museums, archives, libraries and galleries. The Europeana DSI-4 project continues the work of the previous three Europeana Digital Service Infrastructures (DSIs). It is the fourth iteration with a proven record of accomplishment in creating access, interoperability, visibility and use of European cultural heritage in the five target markets outlined: European Citizens, Education, Research, Creative Industries and Cultural Heritage Institutions.

[European Schoolnet](#) (EUN) is the network of 34 European Ministries of Education, based in Brussels. As a not-for-profit organisation, EUN aims to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners. European Schoolnet's task in the Europeana DSI-4 project is to continue and expand the Europeana Education Community.

Annex

1 - The math tale “An irrational love story” is available for printing at

https://archive.org/details/@nonius_adventures





2 – Figures used before the Math Challenge with Kahoot:



MathLapse: Stamping a rosette

Credits

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<https://imaginary.org/film/mathlapse-stamping-a-rosette>

