| **OrientationCompass with solid fill** | **QR audio** |
| --- | --- |

Through the preceding activities, some questions arose regarding the painting "The Bird of Mesarka"...

1. What were the main components of the materials used in the 1962 painting "The Bird of Mesarka"?

2. Can these materials give us information about the artist's technique or socio-economic status?

3. How can a cheap material be transformed into a work of art with cultural and historical value?

*Discuss the above questions in the classroom as a whole*

**How can we answer these questions?**

**Record the results of the discussion**

| ***The students record the results of the discussion, concluding with the following***  **To answer the above questions, we need to:**   * **Zoom in on the object to see details** * **Identify the ingredients from which it is made** * **Identify components that are an indication of preservation** |
| --- |

| *Record the views heard  with a short video or audio recording.  Name it “1.a Problem and Solutions”* | | *QR audio* |
| --- | --- | --- |
| **ConceptualizationQuestions outline** | **QR audio** | | |

* ***Questioning***

**How can we observe item details?**

*Discuss as a whole class.*

* ***Hypothesis Generation***

*Note or draw tools we can use   
to see details of an object*

| Instruments / Devices | Selection |
| --- | --- |
| **Magnifying glass** |  |
| **Binoculars** |  |
| **Telescope** |  |
| **Optical microscope** |  |
| **Close up eye vision** |  |
|  |  |
|  |  |

| ***The students fill in their ideas above or draw the above instruments in this space.*** |
| --- |

*Discuss as a whole class about the instrument that can give us the best results and choose it from the table above.*

***Through the discussion we come to the optical microscope.***

| *Record the views heard  with a short video or audio recording.*  *Name it “1.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | |

* ***Exploration – Experimentation***

Use your mobile devices (tablets, mobiles, etc.) and scan the QR below.

Watch the video and download the results given by your chosen device for the painting by clicking the **"Results"** button.

****

***Discuss with the whole class the results of this particular device***

* ***Data Interpretation***
* In the first point of interest, how does the blue color appear in the Optical Microscope?



Picture 1 Picture 2 Picture 3

***The discussion with the students concludes that we can identify points of interest with the Optical Microscope, such as the area with the bright blue color (Picture 1). By zooming in on the area of interest (blue color) we observe evidence of wear, so we can take a sample without destroying the artifact (Picture 2). The cross-section of the sample (Picture 3) shows us the layer of blue color between the other layers. A discussion can be held with students about how we intervene in an artifact for research or conservation purposes, without destroying/altering it.***

* In the second point of interest, how does the textile look when magnified?



Picture 1 Picture 2: close up observation Picture 3: 10x magnification Picture 4: 40x magnification

***In an area of the painting (Picture 1) the students notice the presence of a textile (Picture 2), so it is interesting for further study. At higher magnification of the Optical Microscope (Picture 3) students can observe that the textile is made up of threads, which in turn are made up of fibers. Picture 4 shows a higher magnification of the textile fibers.***

| *Discuss and record the device functions with a short video or audio recording.*  *Why do we use it and what results can we get?   Name it “1.c Research”* | *QR audio* |
| --- | --- |

| **ConclusionThought outline** | **QR audio** |
| --- | --- |

* **Why do we see three different images for the same point of interest? Can you sort them from lowest to highest magnification?**

**The three images give us an increasingly higher magnification of the same point.**

**The higher the magnification, the greater the detail we can observe.**

* **Do you observe anything different in the images of the different areas of the object we focused on?**

*Write down your observations or draw the pictures below with arrows for the points of special interest.*

| **In the images taken by the Optical Microscope, the points of interest are the blue color of the painting and the area with the textile. So, it would be interesting to get more information about these two points.** |
| --- |

| *Record your answers  in three different short videos or recordings.*  *Name them "1.d Conclusion A", "1.d Conclusion B"* | | *QR audio* |
| --- | --- | --- |
| **ConceptualizationQuestions outline** | **QR audio** | | |

* ***Questioning***

**What do we need to do to get more information   
about points of interest?**

*Discuss as a whole class.*

***A discussion is provoked in the class, in which we guide the students to focus on the need for further magnification.***

***The teacher introduces the Electronic Microscope as a solution for extra magnification.***

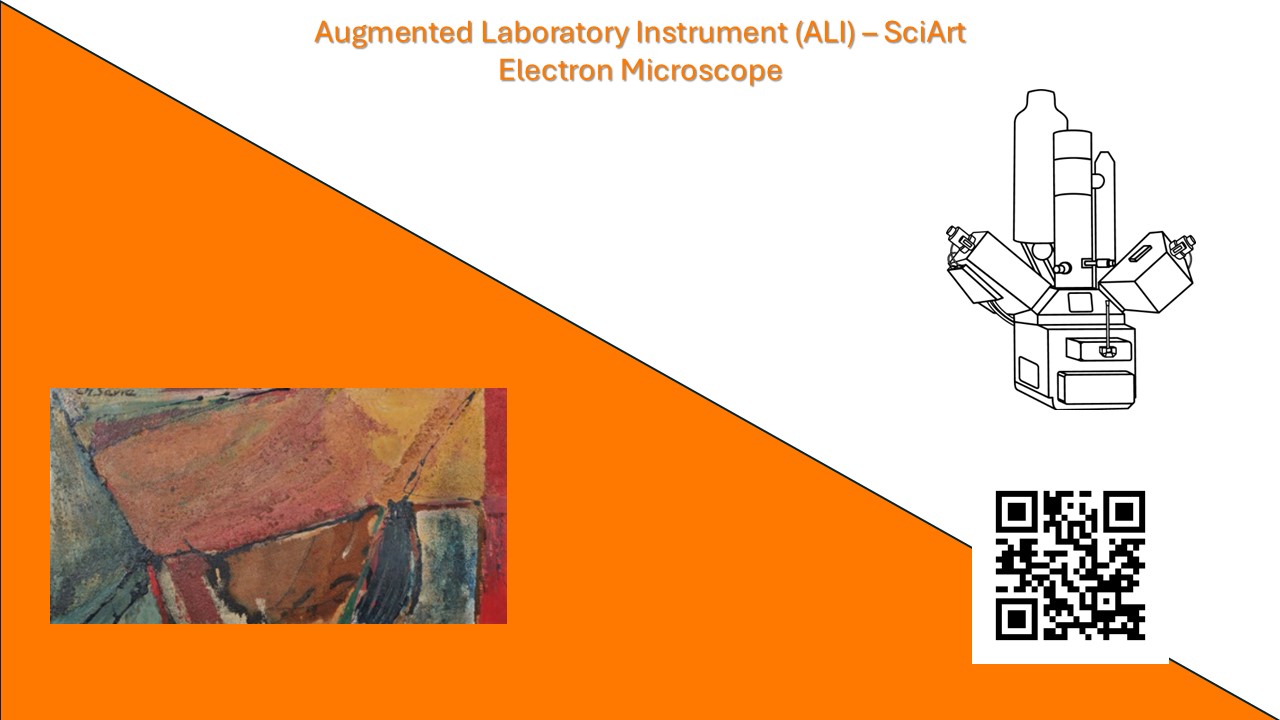
* ***Hypothesis Generation***

| *Record the views heard  with a short video or audio recording.*  *Name it “2.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | | |

* ***Exploration – Experimentation***

Use your mobile devices (tablets, mobiles, etc.) and scan the QR below.

Watch the video and download the results given by the device for the painting by clicking the **"Results"** button.

****

***Discuss the results of this device in the classroom***

* ***Data Interpretation***
* In the first point of interest, from the sample taken from the blue color of the painting, what do you observe in the SEM image? What does the blue layer look like? Can you measure its thickness? How are pigment grains visualized?

***The different black-and-white gradation from the SEM image on the left depicts the blue painting layer (yellow arrow), among the other layers in the painting. We can identify the blue pigment grains of the layer (optionally we can measure the width of each painting layer).***

* In the second point of interest, the sample taken from the textile fibers of the panel, what do you observe in the SEM image? What do textile fibers look like in SEM and what material are they made of?

***The SEM image on the left shows the textile fibers of the painting. The material can be identified from its morphological characteristics. These are linen fibers.***Εικόνα που περιέχει στιγμιότυπο οθόνης, κείμενο

Περιγραφή που δημιουργήθηκε αυτόματα

Εικόνα που περιέχει στιγμιότυπο οθόνης, ασπρόμαυρο, μονοχρωματικό, μονοχρωματική φωτογραφία

Περιγραφή που δημιουργήθηκε αυτόματα



***The SEM image on the left shows an insect found between the textile fibers!***

| *Describe how the device works and what we use it for with a short video or audio recording.*  *Name it “1.c Research”* | *QR audio* |
| --- | --- |

| **ConclusionThought outline** | **QR audio** |
| --- | --- |

* **Which one of the two different points of interest, scanned with the SEM method, has the highest magnification? How can we find it?**

**Image 2 has the highest magnification of 3000x. We can directly read the magnification from the information given at the image's bottom. We can also calculate the magnification from the given scale.**

***The three images have a magnification of 100x (Image 1), 3000x (Image 2) and 250x (Image 3). We can read the magnification in the information given at the image’s bottom. We can also calculate the magnification from the given scale.***

* **Why do we get black and white images?**

**We get black and white images because SEM does not use natural light but electrons.**

***We help students come to the above conclusion by mentioning the video's information.***

* **Comparing the SEM image of the textile with the data from the table, what do you conclude about the material of the textile?**

**By comparing the SEM image of the painting we are studying with the data from the reference image, we conclude that the textile is linen.**

***The students conclude that the textile is made of linen.***

* **What conclusion do we draw from the insect's presence in the painting's textile fibers? Has the textile been used for food storage before?**

***The teacher helps the students conclude that the cloth may have been previously used for storing food.***

* **What do we observe in the images? What might they mean for our subject? Can we conclude the components in the points of interest (blue color and textile fibers)?**
* **No matter how high the magnification of the artifact is, it cannot give us clear answers about the components that the blue color consists of.**
* **We assume from the points of different black-white gradation the existence of different materials. It would be interesting to use a new method to identify the components of the materials.**
* **So, we select the points where the magnification from SEM shows us that there are different materials to find their components with a new method, EDS.**

| *Record your answers  in five different short videos or recordings.*  *Name them "2.d Conclusion A", "2.d Conclusion B",  "2.d Conclusion C", "2.d Conclusion D",  "2.d Conclusion E"* | | *QR audio* |
| --- | --- | --- |
| **ConceptualizationQuestions outline** | **QR audio** | |

* ***Questioning***

**What do we need to do to find the components   
of the points of interest of the artifact we are studying?**

**What should we recognize?**

*Discuss as a whole class.*

***A class discussion is provoked which leads to the need to identify the elements that the materials in the areas of interest (blue colour, textile) are made of.***

***The teacher introduces the EDS method for the elemental analysis of the selected points. "EDS is an analytical method used to identify the elements found in a sample."***

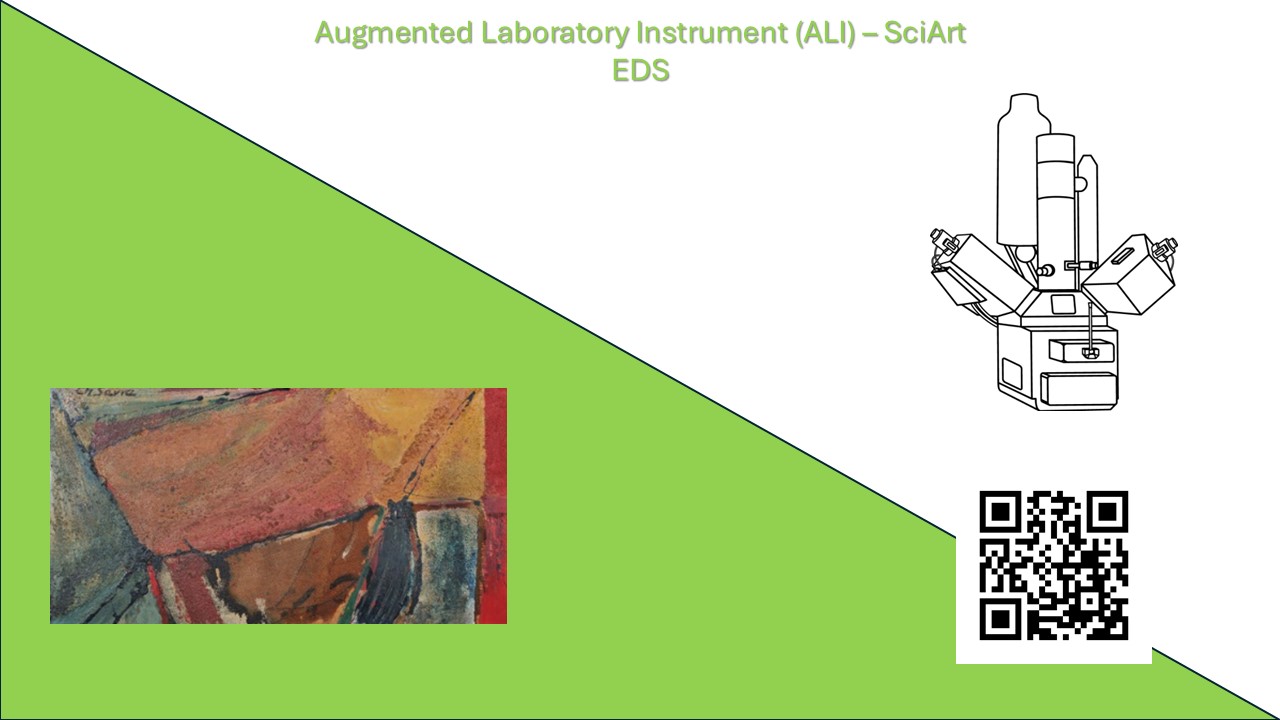
* ***Hypothesis Generation***

| *Record the views heard  with a short video or audio recording.*  *Name it “1.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | | |

* ***Exploration – Experimentation***

Use your mobile devices (tablets, mobiles, etc.) and scan the QR below.

Watch the video and download the results of the method for the painting by clicking the **"Results"** button.

****

***Study in your group and then discuss with the whole class   
the results of this particular method***

***Students observe the spectrum and table of elements and identify the elements of the sample.***

***The teacher explains to the students that an EDS spectrum is only obtained by selecting points of interest from the SEM images and asks the students to identify the elements found in the spectrum by the EDS method.***

* ***Data Interpretation***
* In the first point of interest, from the sample taken from the blue color layer, what do you observe in the EDS spectrum? What elements does it consist of?



***This is the spectrum we get from the EDS method for the blue color layer of the painting. It is mainly composed of aluminum, silicon and oxygen.***

* In the second point of interest, from the sample taken from the textile fibers of the panel, what do you observe in the EDS spectrum? What elements does linen, as an organic material, consist of?

***This is the spectrum we get from the EDS method for the region of interest of the panel textile. The elemental analysis shows that it consists of carbon and oxygen. This is a typical range of organic materials. The identification of the linen fibers was already completed by their morphological characteristics with SEM. Here the connection is made that linen, as the organic material, is composed of O and C.***

**Look for materials containing the elements found in our artifact in the source given below (QR) and list possible materials.**

**QR link to the database**

***Students open the database and search for the materials in which the chemical elements (focusing on the ratio of the elements) identified through the method are found.***

***Discuss with your class the results of your investigation from the database.***

| **Name** | **Compound** | **Photo** |
| --- | --- | --- |
| Smalt | SiO2 + K20 + Al2O3 |  |
| Synthetic ultramarine | 3Na2 O·3Al2O3 ·6SiO2 ·2Na2S |  |
| Natural ultramarine or lapis lazuli | (Na,Ca)8(AlSiO4)6(S,SO4,Cl)1-2 |  |

| *Discuss and record how the method works with a short video or audio recording.*  *What results did it give us? What else did we have to do?*  *Name it “3.c Research”* | | *QR audio* |
| --- | --- | --- |
| **ConclusionThought outline** | **QR audio** | | |

List the materials in which the elements are found in our sample in the table below.

| **Points of interest** | **Chemical Compounds** |
| --- | --- |
| Blue paint on the painting board | **smalt, synthetic ultramarine, natural ultramarine or lapis lazuli** |
| Textile fibers of the painting | **Organic compound that confirms in conjunction with SEM results that the textile is made of linen fibers** |

| *Record your answers  in a short video or audio recording.*  *Explain how you got there.*  *Name them "3.d Conclusion"* | | *QR audio* |
| --- | --- | --- |
| **ConceptualizationQuestions outline** | **QR audio** | | |

* ***Questioning***

**Is the evidence found in more than one material?   
If so, is there any difference between the materials you can observe in the database?**

*Discuss as a whole class.*

***The teacher asks the students to focus on the information given in the database to notice that the materials, containing the elements we are looking for, are found in more than one chemical compound that is different from each other.***

**What do you notice that is different and what should we identify   
to limit the materials?**

***The above observation makes it necessary to limit the possible compounds present in our sample. The discussion highlights the need for further analysis to identify a specific chemical compound. Students will use the FTIR method.***

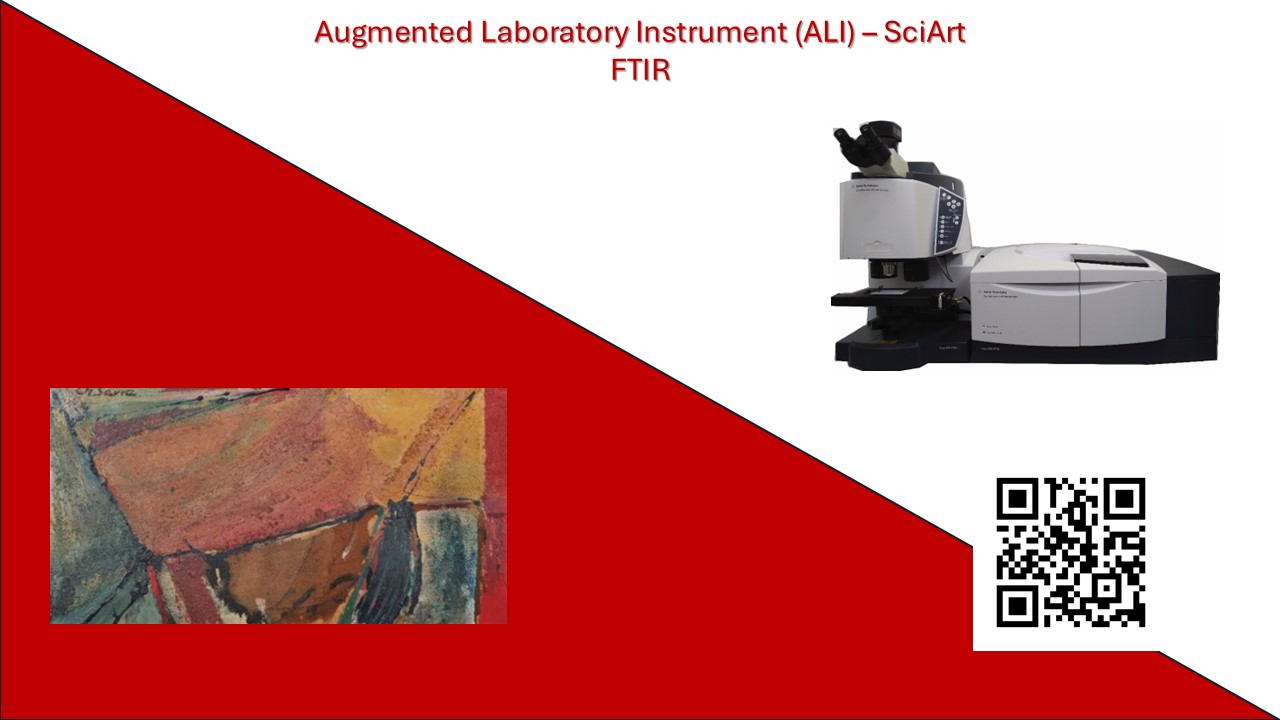
* ***Hypothesis Generation***

| *Record the views heard  with a short video or audio recording.*  *Name it “4.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | | |

* ***Exploration – Experimentation***

Use your mobile devices (tablets, mobiles, etc.) and scan the QR below.

Watch the video and download the results of the method for the painting by clicking the **"Results"** button.

****

***Discuss the results of this method with the whole class***

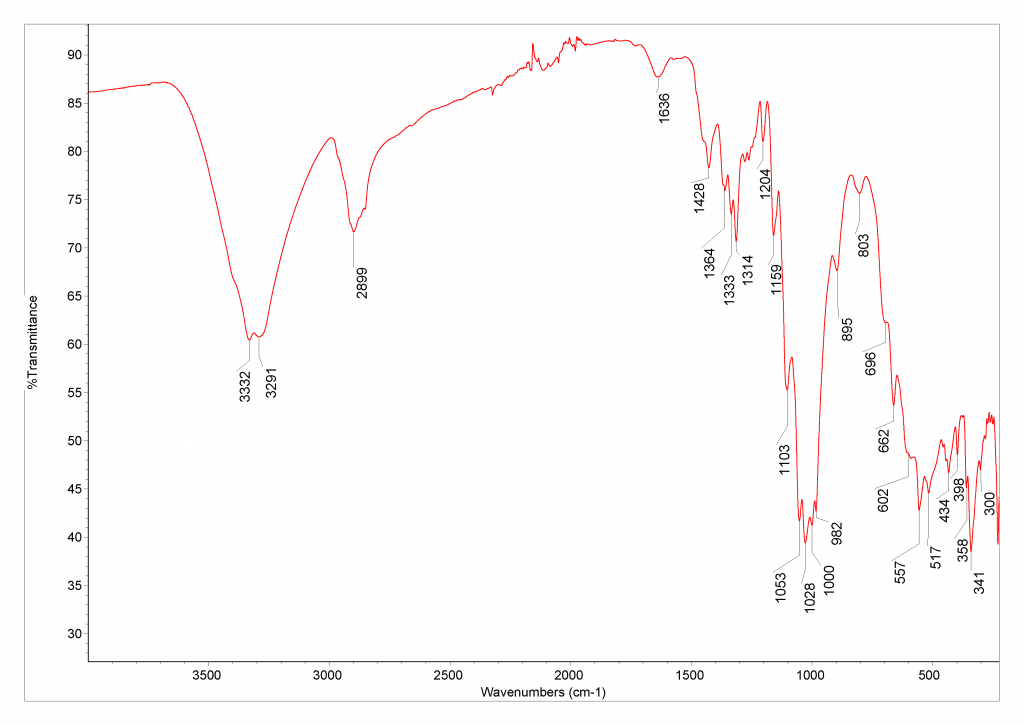
* ***Data Interpretation***
* In the first point of interest, the sample from the blue color layer, what do you observe in the FTIR spectrum?

Εικόνα που περιέχει κείμενο, διάγραμμα, σκίτσο/σχέδιο, γραμμή

Περιγραφή που δημιουργήθηκε αυτόματα

***The FTIR method gives us results for the blue color. The pigment identified is ultramarine. The inverted peak at 2342 cm -1 is characteristic of natural ultramarine.***

* In the second point of interest, the sample from the textile fibers of the panel, what do you observe in the FTIR spectrum? What type of fiber is linen fiber?

***The FTIR method for the textile region gives a spectrum with inverted peaks, indicating that the material is composed of plant fibers.***

| *Discuss and record how the method works  with a short video or audio recording. What results did it give us?*  *Name it “4.c Research”* | | *QR audio* |
| --- | --- | --- |
| **ConclusionThought outline** | **QR audio** | | |

* **Which compound was identified for the blue pigment?**

| **Natural ultramarine** |
| --- |

* **Which compound was identified in the textile by FTIR?**

| **Cellulose (C6H10O5)** |
| --- |

| *Record your answers  in a short video or audio recording.*  *Explain how you got there.*  *Name them "4.d Conclusion"* | | *QR audio* |
| --- | --- | --- |
| **ConceptualizationQuestions outline** | **QR audio** | | |

* ***Questioning***

**What difference does the XRD method give for the points of interest?***Discuss as a whole class.*

***The teacher introduces the XRD method which will give additional information from the previous methods about the origin of natural ultramarine.***

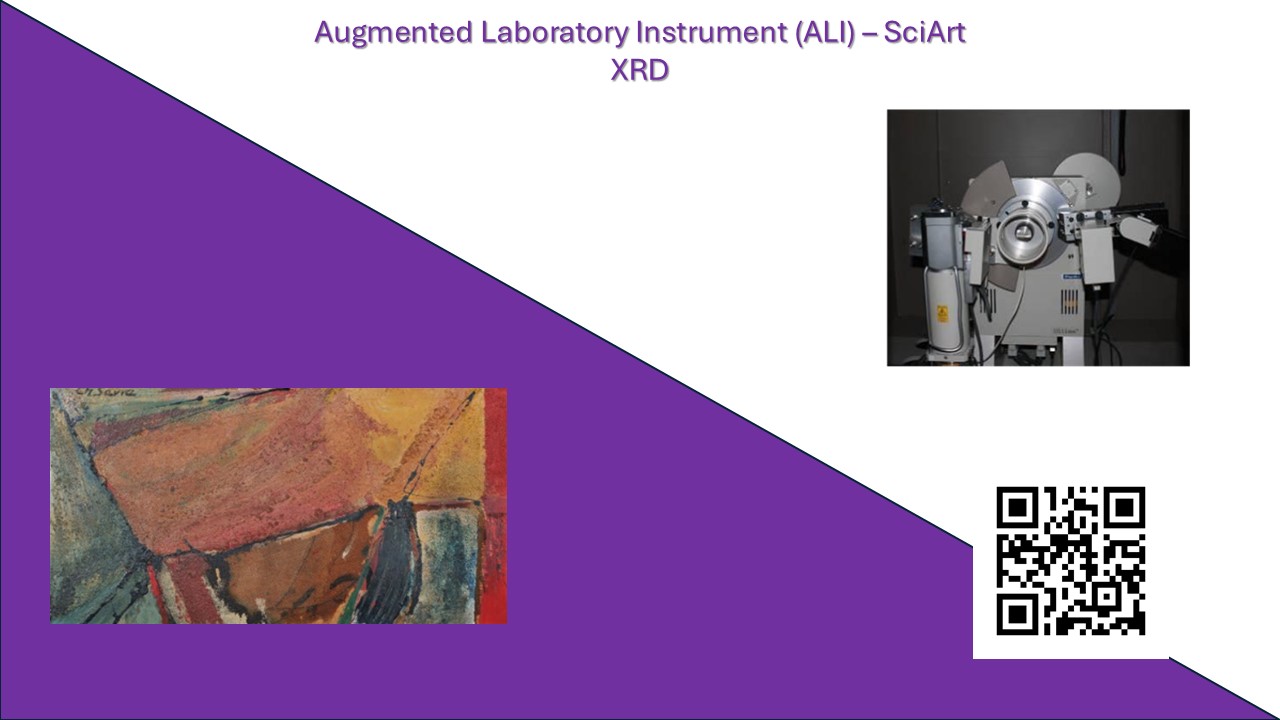
* ***Hypothesis Generation***

| *Record the views heard  with a short video or audio recording.*  *Name it “5.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | | |

* ***Exploration – Experimentation***

Use your mobile devices (tablets, mobiles, etc.) and scan the QR below.

Watch the video and download the results of the method for the painting by clicking the **"Results"** button.

****

***Discuss in the whole class the results of this particular method***

* ***Data Interpretation***

***Students observe the diffractogram graph. The teacher initiates a discussion about the necessity to ascertain the region of origin of natural ultramarine.***

* In the first point of interest, the color blue, based on the XRD pattern, can you identify the minerals that make up this particular natural ultramarine and their percentages?

***The XRD pattern for the sample's blue pigment identifies four minerals (lazurite (22.1%), diopsite (54.9%), phlogopite (20.6%) and sodalite (2.41%)) that comprise the specific natural ultramarine.*** Εικόνα που περιέχει διάγραμμα, κείμενο, γραμμή, σκίτσο/σχέδιο

Περιγραφή που δημιουργήθηκε αυτόματα

Εικόνα που περιέχει χάρτης, κείμενο, Άτλας

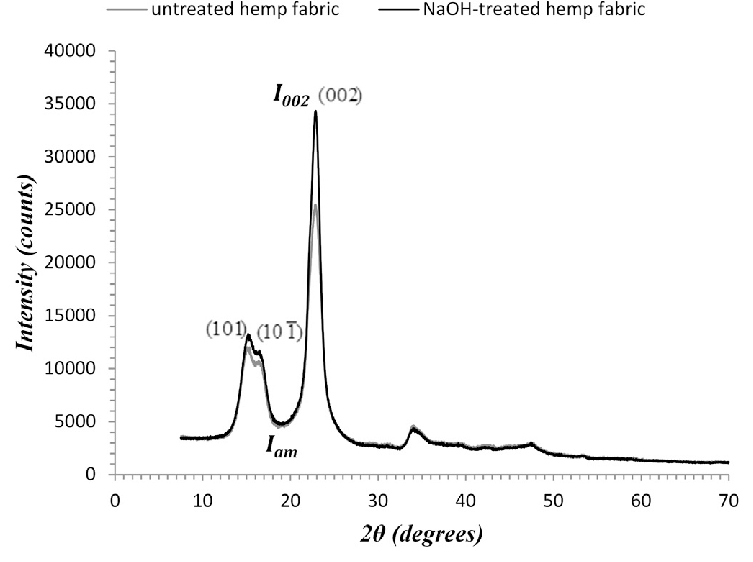
Περιγραφή που δημιουργήθηκε αυτόματα

Εικόνα που περιέχει κείμενο, στιγμιότυπο οθόνης, γραμματοσειρά, αριθμός

Περιγραφή που δημιουργήθηκε αυτόματα

* On which continent is the particular natural ultramarine of the painting's blue color mined?

***This particular natural ultramarine is mined in the Afghanistan region.***



***The XRD pattern for the textile confirms that we have cellulose.***

| *Discuss and record how the method works  with a short video or audio recording.*  *What results did it give us?*  *Name it “4.c Research”* | | *QR audio* |
| --- | --- | --- |
| **ConclusionThought outline** | **QR audio** | | |

* **In the table below, summarize the information you have obtained about the mining area of this particular natural blue color ultramarine and the basic material from which all plant-based textiles are made, such as linen.**

| **Points of interest** | **Chemical Compounds** |
| --- | --- |
| Blue color | **Natural ultramarine from the Afghanistan region** |
| Textile | **Plant-based fabrics, such as linen, are composed of cellulose.** |

| *Record your answers  in a short video or audio recording.*  *Explain how you got there.*  *Name them "4.d Conclusion"* | *QR audio* |
| --- | --- |

**Back to the initial questions…**

1. What were the main components of the materials used in the 1962 painting "The Bird of Mesarka"?

2. Can these materials give us information about the artist's technique or socio-economic status?

3. How can a cheap material be transformed into a work of art with cultural and historical value?

| **ConceptualizationQuestions outline** | **QR audio** |
| --- | --- |

* ***Questioning***

**How can we use the conclusions drawn from archaeometric methods to answer the initial questions?**

*Discuss as a whole class.*

* ***Hypothesis Generation***

*Please provide questions that you can ask an AI machine. The answers it gives you, combined with the results you already have, will help address the initial questions.*

| ***The teacher facilitates a class discussion to formulate the questions that students need to address the above questions. Such questions may be:***   * **What is the value of the particular materials and how rare were they?** * **Where are these materials located?** |
| --- |

| *Record the questions you will ask on ChatGPT with a short video or audio recording.*  *Name it “6.b Conceptualization”* | *QR audio* |
| --- | --- |
| **Investigation Research with solid fill** | **QR audio** |

Use ChatGPT to get information on the above questions. Write down the information you need to answer the questions.

| **Question** | **Main ChatGPT Answer Points** |
| --- | --- |
| What materials and pigments are used in paintings today? | **………** |
| In which geographical areas do we find natural ultramarine? | **………** |
| What is the difference between natural and synthetic ultramarine? | **………** |
| Is linen used in vegetable sacks? | **………** |
|  |  |
|  |  |

*Discuss in class the answers  
to the specific questions you posed on ChatGPT*

* ***Data Interpretation***

| *Note the main points of the answers for each question.  Did it help you find the answer?  How?*  *Name it “4.c Research”* | | *QR audio* |
| --- | --- | --- |
| **ConclusionThought outline** | **QR audio** | | |

*Record the answers to the initial research questions.*

| **1. What were the main components of the materials used in the 1962 painting "The Bird of Mesarka"?** |
| --- |
| ***The main materials from the samples we studied: the blue pigment (natural ultramarine) and the linen textile*** |
| **2. Can these materials give us information about the artist's technique or socio-economic status?** |
| ***…………….*** |
| **3. How can a cheap material be transformed into a work of art with cultural and historical value?** |
| ***……………………………*** |

|  | *QR audio* |
| --- | --- |

**Create a video of your answer to each   
interview question.**

**One of you will ask the question**

**and the other person will answer!!!!**

*Name the videos "Final Answer 1", "Final Answer 2", etc.*