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# Guidelines for the Design of Technology Enhanced Science Education Learning Content



## OpenScienceResources Metadata Authoring Tool Manual

**OpenScienceResources:**  
Towards the development of a Shared Digital  
Repository for Formal and Informal Science Education



*eContentPlus*



Contact Number: ECP-2008-EDU-428045

**Guidelines for the Design of  
Technology-Enhanced Science Education  
Learning Content  
OpenScienceResources  
Metadata Authoring Tool Manual**

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Towards the development of a Shared Digital  
Repository for Formal and Informal Science Education



*eContentPlus*

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The OSR ASK Learning Objects Metadata Authoring Toolkit (OSR ASK LOM-AT) is owned by the Research Unit on Advanced Learning Technologies and Services for Education and Learning (<http://www.ask4research.info/>) and it was customized to support the process of characterizing the science education resources and educational pathways of the OSR Portal (<http://www.osrportal.eu/>). OSR ASK-LOM-AT was not developed within the framework of the OSR Project (Contract Number: ECP-2008-EDU-428045), but it was selected as the most appropriate available toolkit for meeting the project's needs. The Research Unit on Advanced Learning Technologies and Services for Education and Learning reserves all rights and retains ownership of all copies of the OSR ASK Learning Objects Metadata Authoring Toolkit (OSR ASK LOM-AT) and its use beyond the OSR Project Activities.

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# 1. OSR Learning Objects Metadata Authoring Toolkit (OSR ASK-LOM-AT)

This Chapter presents the functionalities of the OSR Learning Objects Metadata Authoring Toolkit (OSR ASK-LOM-AT) which is conformant with the OSR IEEE LOM Application Profile

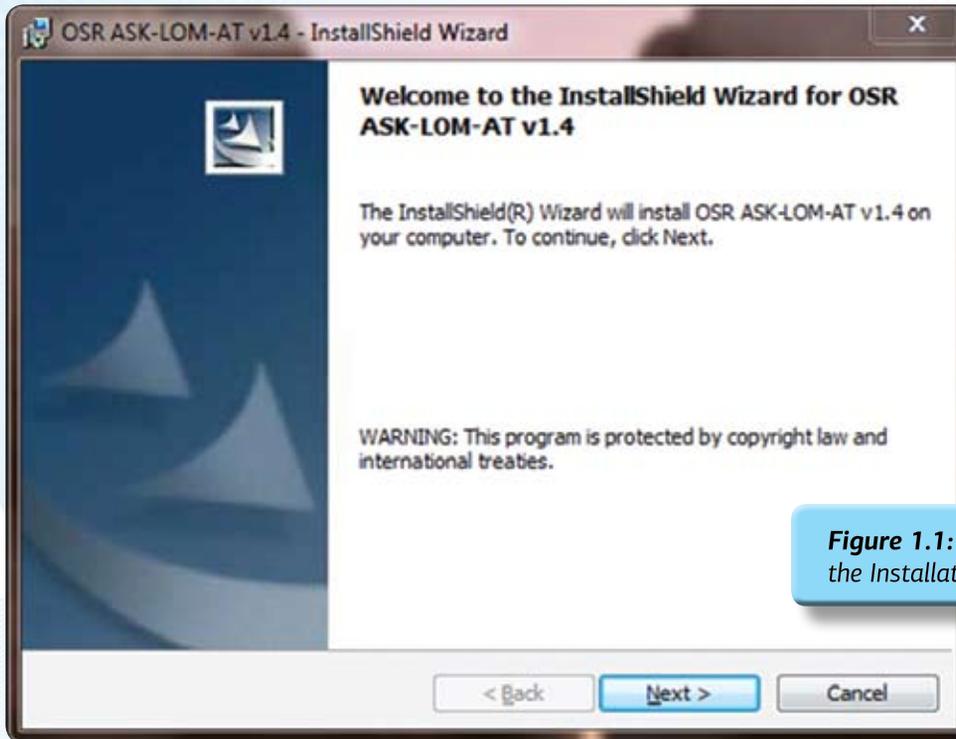
## 1.1 General Description and Functionalities

**OSR Learning Objects Metadata Authoring Toolkit (OSR ASK-LOM-AT)** facilitates authoring and management of educational and science education related metadata following the OSR IEEE LOM Application Profile. The main functionalities of OSR ASK-LOM-AT include:

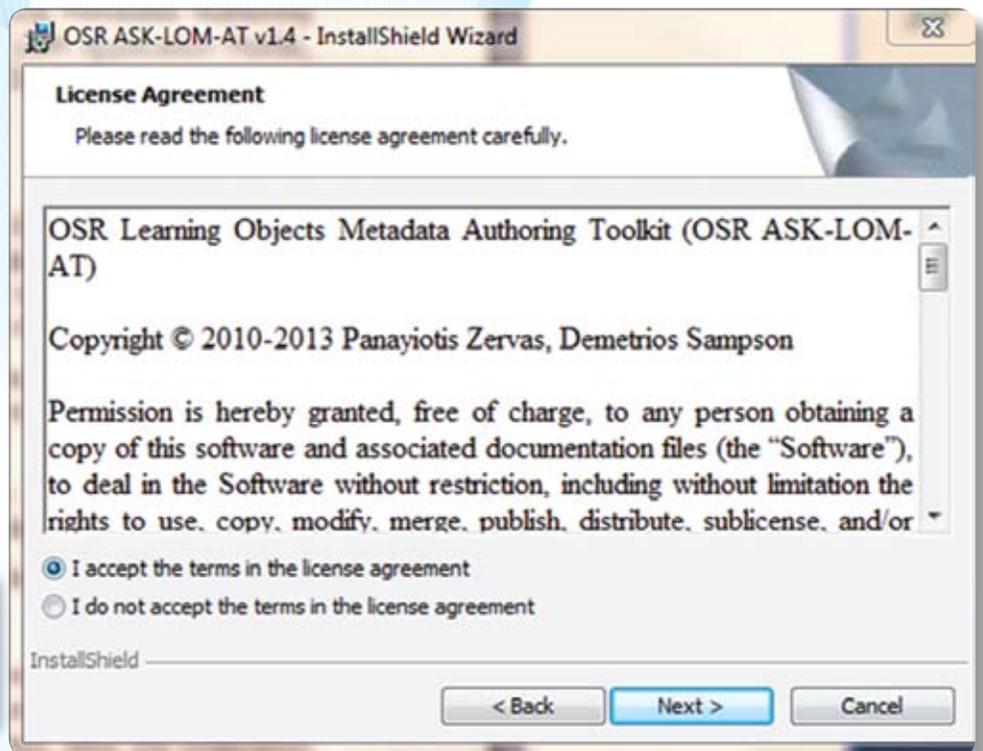
- Educational metadata authoring of science educational resources and educational pathways following the OSR IEEE LOM Application Profile, through the use of a step-by-step authoring wizard.
- Educational metadata records management and creation of Science Education Resources and Educational Pathways Local Educational Metadata Repository.
- Export of individual educational metadata records as XML files conformant with the IEEE LOM Standard<sup>1</sup>

In order to start the OSR ASK-LOM-AT you have to run the file named **OSR ASK-LOM-AT v1.4.msi**. A window will appear asking you to proceed with the installation process. You have to follow all the steps of the process by pressing the **“Yes”** button. After the finalization of the installation the following message will appear: “The Installation completed successfully” (See Figure 1.1, Figure 1.2, Figure 1.3 and Figure 1.4).

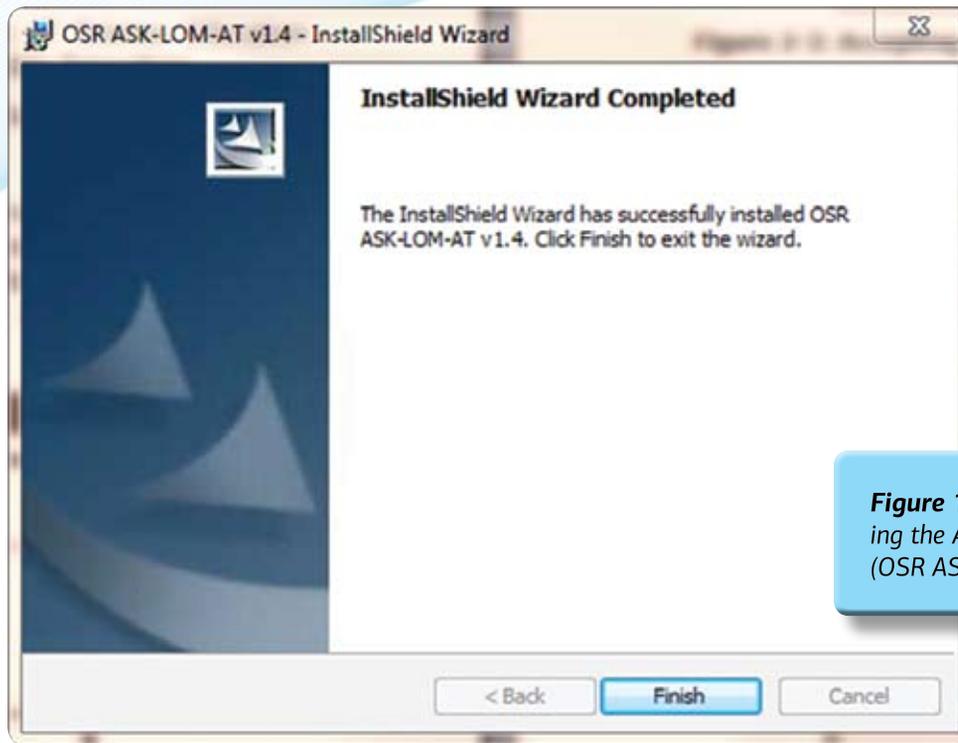
<sup>1</sup> IEEE LOM (2002) Draft Standard for Learning Object Metadata, IEEE Learning Technology Standards Committee (LTSC), Available at: [http://ltsc.ieee.org/wg12/files/LOM\\_1484\\_12\\_1\\_v1\\_Final\\_Draft.pdf](http://ltsc.ieee.org/wg12/files/LOM_1484_12_1_v1_Final_Draft.pdf)



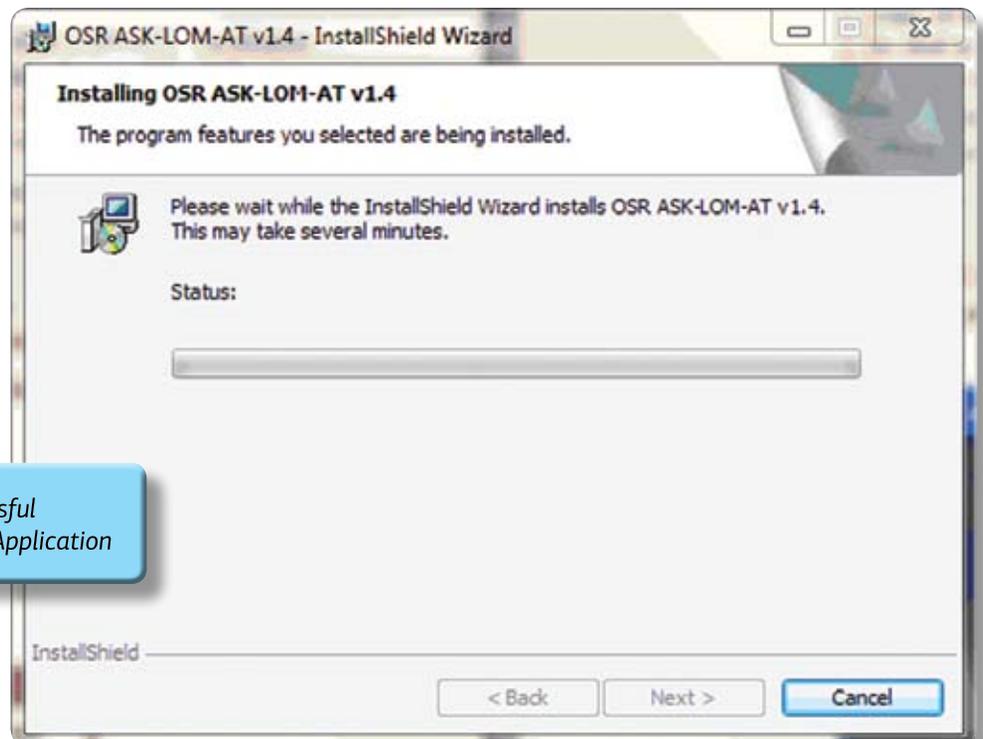
**Figure 1.1:** Starting Up the Installation Process



**Figure 1.2:** Accepting the License Agreement of the Application

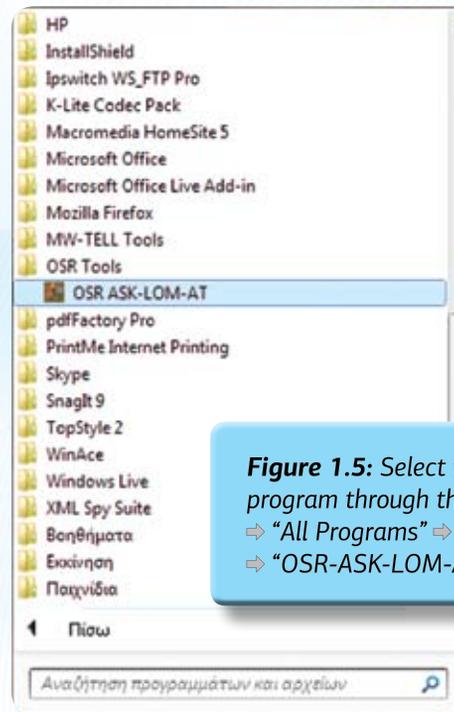


**Figure 1.3:** Installing the Application (OSR ASK-LOM-AT)



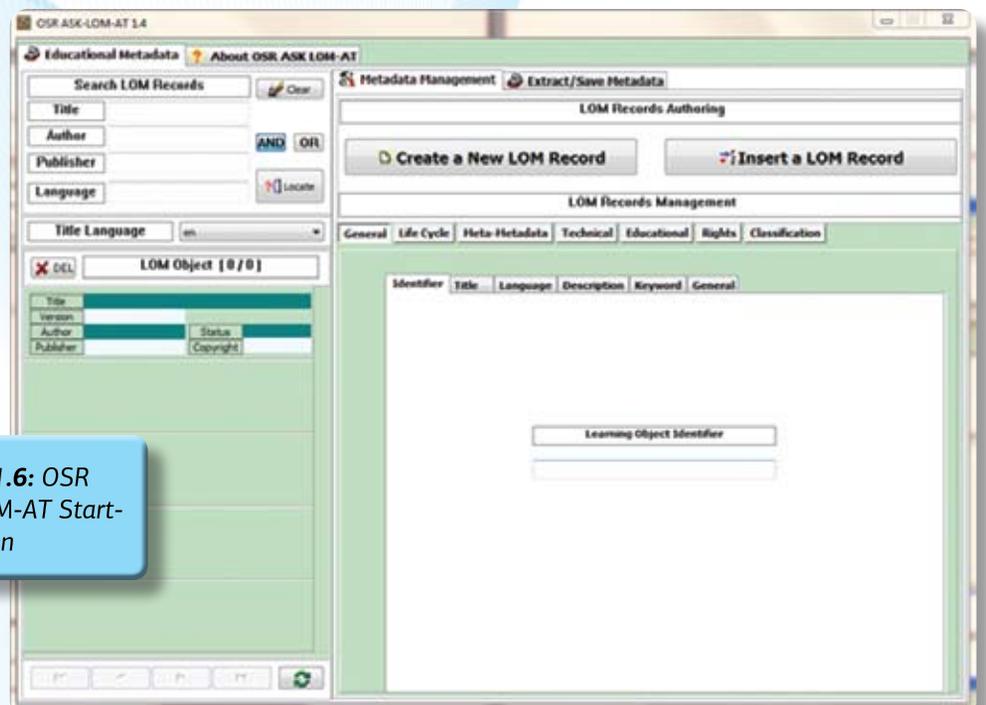
**Figure 1.4:** Successful Installation of the Application

After the successful installation process a new Group will be added to the “Programs Group” with the name “OSR Tools”, which contains the OSR ASK-LOM-AT application. The execution of the application can be done by clicking the choice “OSR-ASK-LOM-AT”.



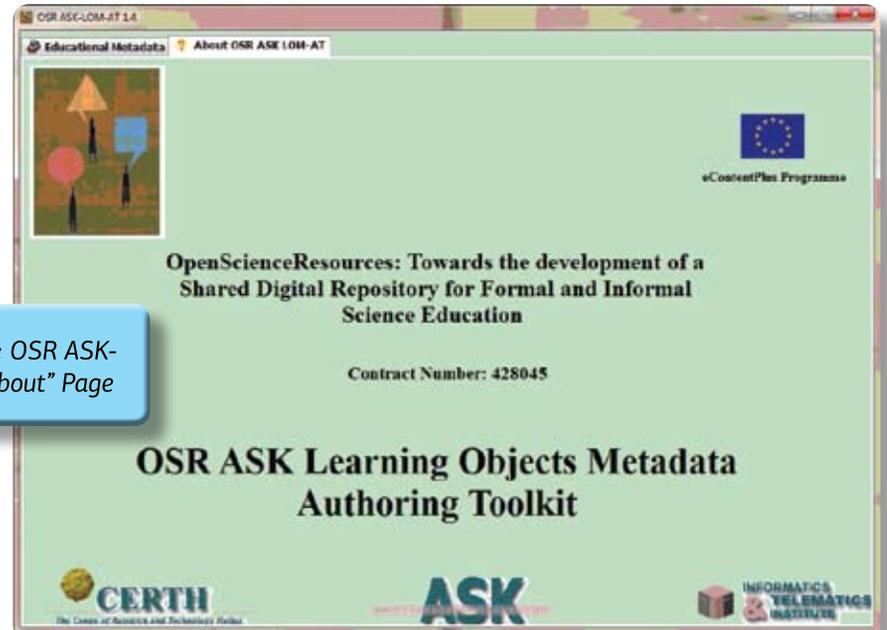
**Figure 1.5:** Select to run the program through the menu “Start”  
⇒ “All Programs” ⇒ “OSR Tools”  
⇒ “OSR-ASK-LOM-AT”

Provided that the installation process is completed successfully the first screen of the OSR ASK-LOM-AT will appear (see Figure 1.6).



**Figure 1.6:** OSR ASK-LOM-AT Start-up Screen

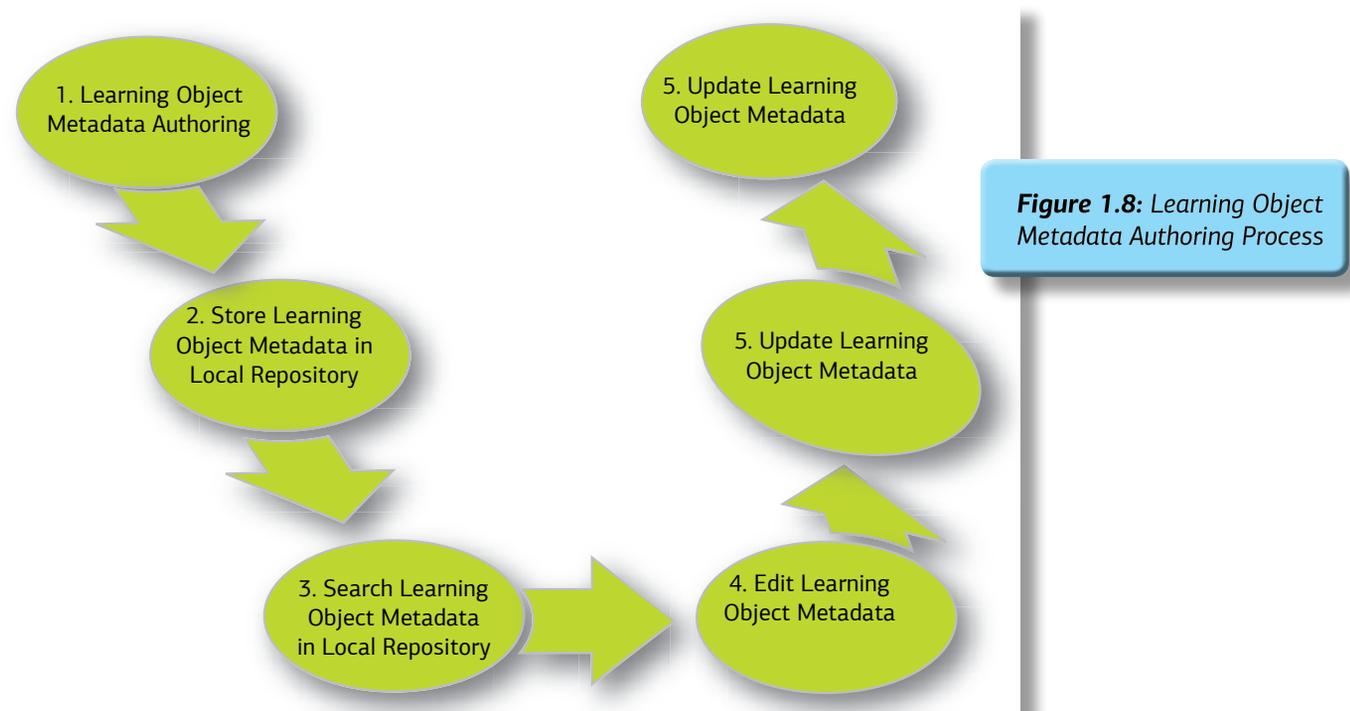
By clicking the tab “**About OSR ASK-LOM-AT**” you can see the about page of the application (see Figure 1.7), which includes information on the project and information about the organization, which developed the Tool.



**Figure 1.7:** OSR ASK-LOM-AT “About” Page

## 1.2 OSR ASK-LOM-AT Authoring Process

Figure 1.8 depicts the Learning Object Metadata authoring process with the use of OSR ASK-LOM-AT.



**Figure 1.8:** Learning Object Metadata Authoring Process

The Learning Object Metadata authoring process consists of six (6) basic steps. All steps are depicted in Figure 1.8 and presented below:

- **Step 1 – Learning Object Metadata Authoring:** During this step the user is using a step-by-step wizard in order to characterize with educational metadata a specific learning object (science education resources or educational pathway).
- **Step 2 – Store Learning Object Meta data in Local Repository:** After the finalization of Step 1 the learning object educational metadata record is stored to the local repository of the Tool.
- **Step 3 – Search Learning Object Metadata in Local Repository (Optional):** This is an optional step and the user during this step is able to search the local repository of the tool, so as to find the metadata record that has just been stored.
- **Step 4 – Edit Learning Object Metadata (Optional):** This is an optional step and the user during this step is able to edit various metadata elements of the newly added learning object metadata record.
- **Step 5 – Update Learning Object Metadata (Optional):** This is an optional step and the user during this step is able to update the metadata elements' values that he/she has edited in the previous step.
- **Step 6 – Export Learning Object Metadata Record to XML format:** During this final step the user is using the OSR ASK-LOM-AT in order to export the educational metadata record to XML format (conformant with IEEE LOM Standard). This step is essential in order to be able to upload the learning object and its metadata record to the OSR Portal, so that other users of the Portal can search for it and retrieve it for future usage.

### 1.2.1 Use the OSR ASK-LOM-AT Wizard

The OSR ASK-LOM-AT facilitates authoring and storing of learning objects metadata descriptions in the local repository, by selecting “**Create New LOM Object**” option (see Figure 1.10). This feature launches the specially developed Learning Object Metadata Authoring Wizard that guides the user through a simple step-by-step process of the OSR IEEE LOM Application Profile.

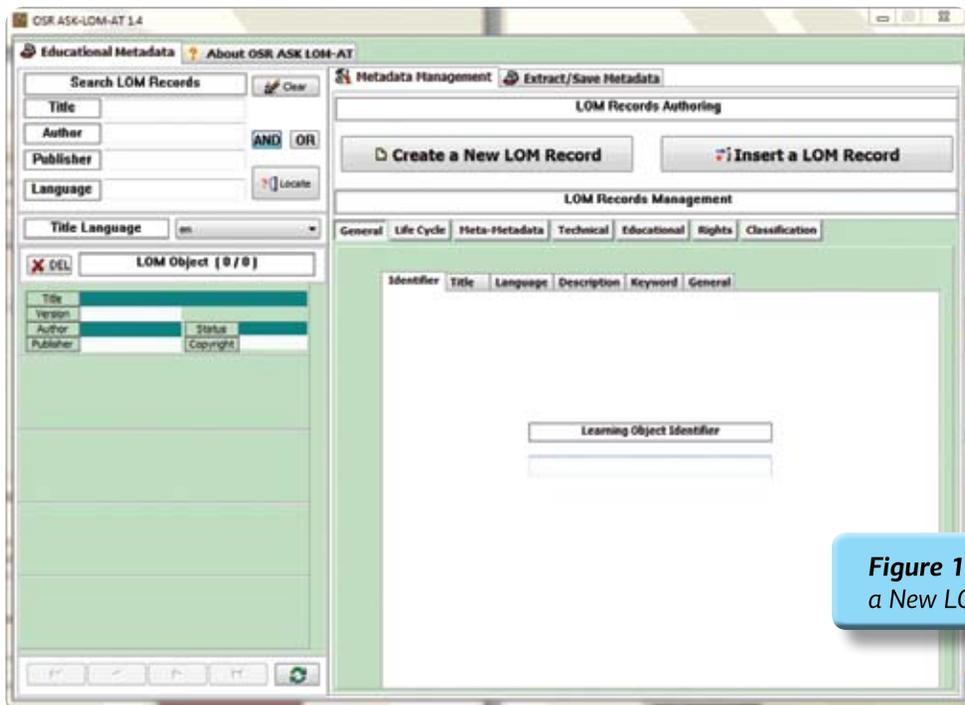
The Wizard presents guidelines to the user in every step regarding metadata authoring. There are different alternatives of metadata authoring, depending on the type of the element:

- Data can be filled in the form of free text. An example is the case of the Title element (see Figure 1.13).
- A metadata element value can be filled from a pre-defined list of values. An example is the case of the Structure element (see Figure 1.18).
- Multiple data records can be added in one metadata element, when this is allowed by the Application Profile. An example is the case of the Keyword element (as there might exist more than one keywords) (see Figure 1.17).

After the metadata authoring is completed (see Figure 1.36) the metadata are automatically stored in the Local Learning Object Metadata Repository.

In order to author Learning Object Metadata using the OSR ASK-LOM-AT Wizard you have to follow the steps described below in this Section.

1. Select the Tab **'Educational Metadata'** and press the Button **'Create a New LOM Record'** (see Figure 1.9).
2. Click **'Start'** to begin the Wizard (see Figure 1.10) (Suppose that the learning object we want to characterize with metadata is an explanatory text regarding Electromagnetic Spectrum).



**Figure 1.9:** Create a New LOM Record



**Figure 1.10:** Initial Screen of the Learning Object Metadata Authoring Wizard

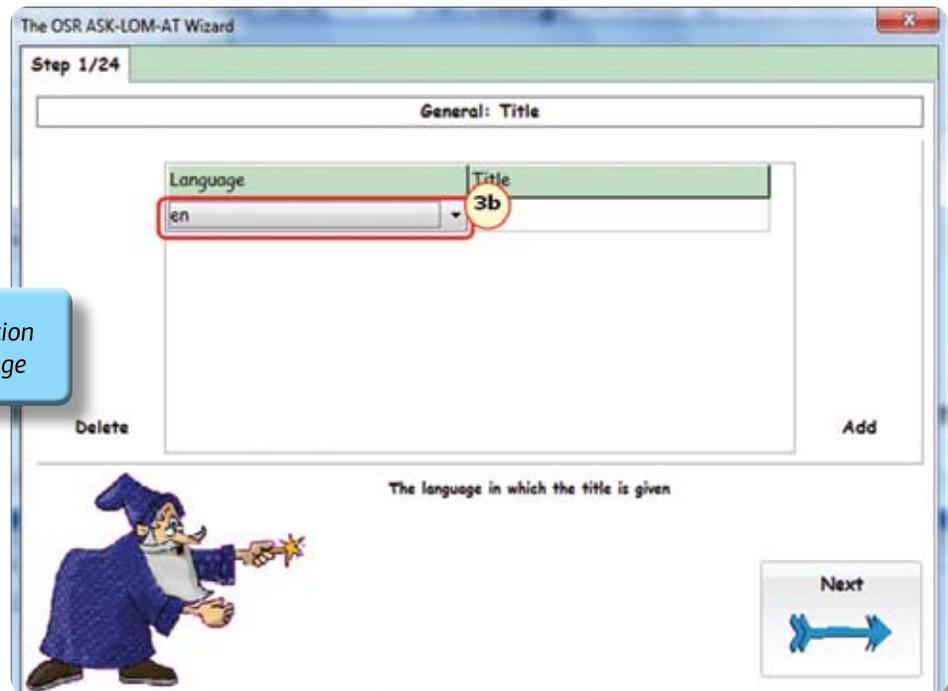
3. Give the 'Title' of the learning object (see Figure 1.13).
  - a. Read the dialog that describes the element 'Title' (see Figure 1.11).



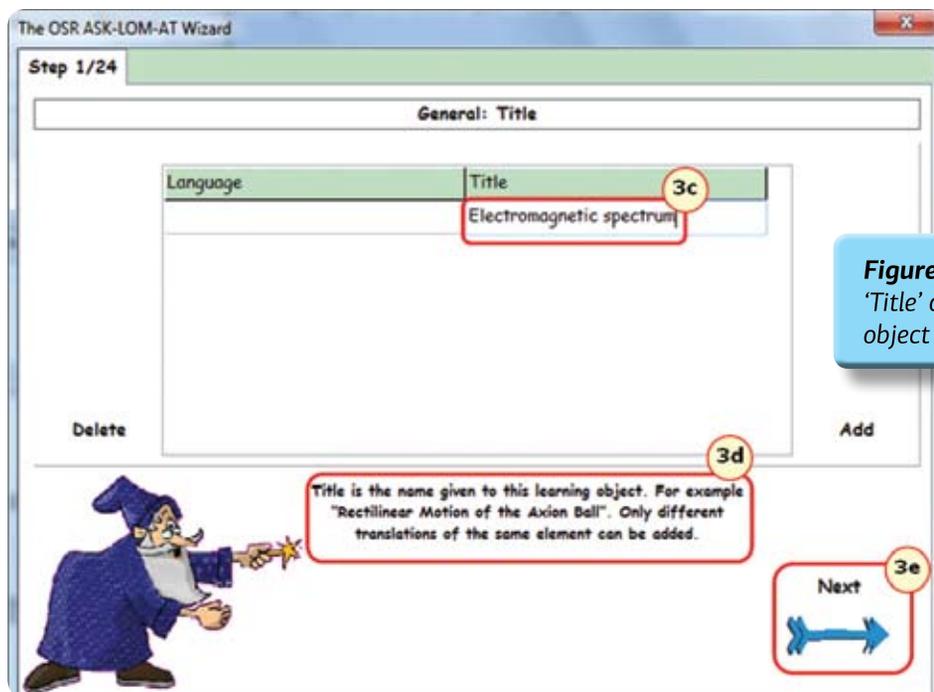
**Figure 1.11:** Dialog that describes the metadata element

- b. Select the 'Language' in which the title of the learning object will be provided (see Figure 1.12).

**Figure 1.12:** Selection of the Title's language



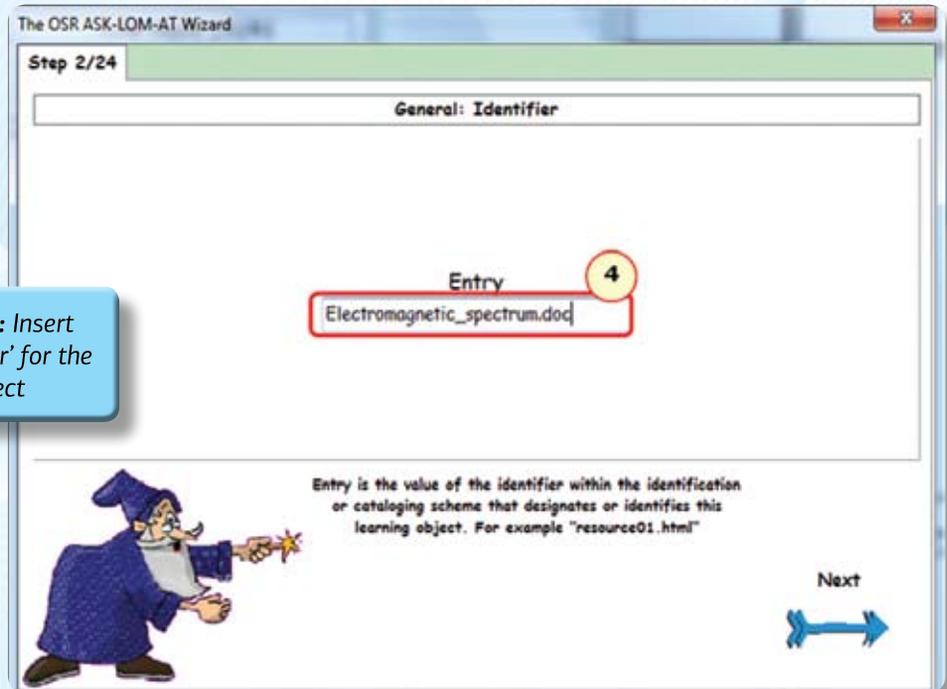
- c. Read the dialog that describes the value of the element 'Title' (see Figure 1.13).  
 d. Insert the 'Title' of the learning object (see Figure 1.13).  
 e. Click 'Next' to continue (see Figure 1.13).



**Figure 1.13:** Insert the 'Title' of the learning object

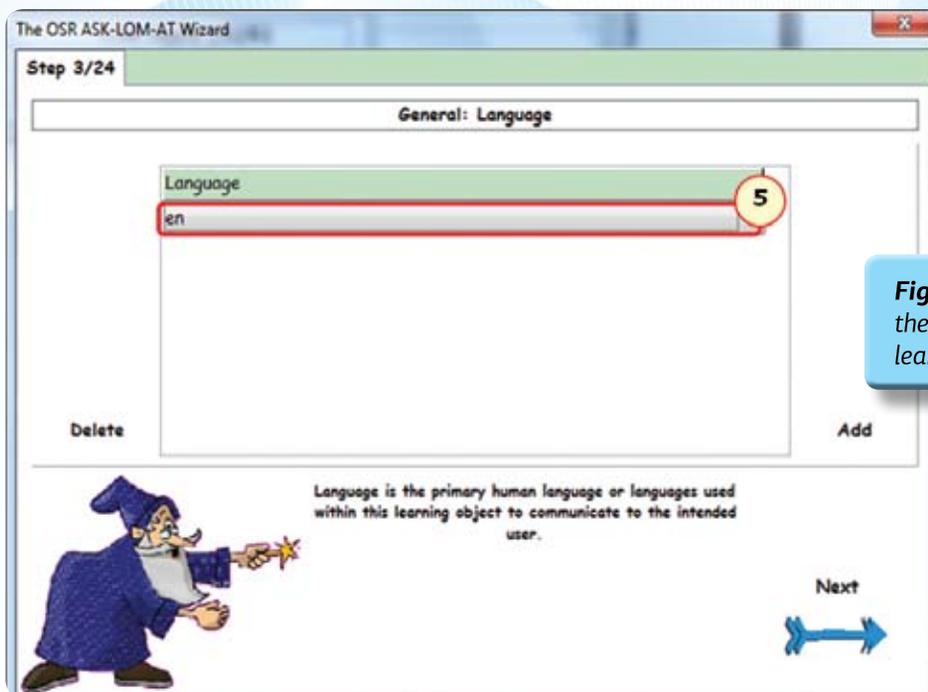
4. Insert the 'Identifier' of the learning object. The identifier will be the filename of the learning object you are describing, i.e. FreeFall.swf (see Figure 1.14).

**Figure 1.14:** Insert the 'Identifier' for the learning object



5. Insert the 'Language' or the languages used within the learning object to communicate to the intended user (see Figure 1.15).

**Figure 1.15:** Insert the 'Language' of the learning object



6. Insert the **'Description'** of the content of the learning object.

The OSR ASK-LOM-AT Wizard

Step 4/24

General: Description

Language	Description
en	Exhibit on light waves

Delete Add

The language in which the description is given

Next

**Figure 1.16:** Insert the 'Description' of the content of the learning object

7. Give a 'Keyword' or phrase describing the topic of the learning object (see Figure 1.17).
- Insert the first keyword for the learning object.
  - Click 'Add' to add a second keyword.
  - Insert the second keyword for the learning object.

The OSR ASK-LOM-AT Wizard

Step 5/24

General: Keyword

Language	Keyword
en	Sunlight
en	Electromagnetic waves

Delete Add

Give a Keyword for this learning object

Next

**Figure 1.17:** Insert 'Keyword(s)' for the learning object

8. Give the 'Structure' and the 'Aggregation Level' of the learning object (see Figure 1.18).
  - a. Select the 'Structure' of the learning object using the given list. The available choices are:
    - Atomic: an object that is indivisible
    - Collection: a set of objects with no specified relationship between them.
    - Networked: a set of objects with relationships that are unspecified.
    - Hierarchical: a set of objects whose relationships can be represented by a tree structure.
    - Linear: a set of objects that are fully ordered. Example: A set of objects that are connected by "previous" and "next" relationships.
  - b. Select the 'Aggregation Level' of the learning object using the given list. The available choices are:
    - 1: the smallest level of aggregation, e.g., astronomic images, worksheets, etc.
    - 2: a collection of learning objects, e.g., a learning activity

The OSR ASK-LOM-AT Wizard

Step 6/24

General: Structure + Aggregation Level

Structure 8a

atomic

Aggregation Level 8b

educational content

Aggregation Level is the functional granularity of this learning object. Please choose from the predefined list: educational content (any learning resource, from a single file to a complex exhibit or a whole exhibition), educational pathway (a plan for using a meaningful combination of various instances of educational content)

Next

**Figure 1.18:** Insert the 'Structure' and the 'Aggregation Level' of the learning object

9. Insert the name of the **'Author'** of the learning object (see Figure 1.19).

The OSR ASK-LOM-AT Wizard

Step 7/24

LifeCycle: Contribute (Author)

Entity

Eugenides Foundation

Delete Add

The institution/person that has created/authored/produced the resource

Next

**Figure 1.19:** Insert the name of the 'Author' of the learning object

10. Insert the name of the **'Publisher'** of the learning object (see Figure 1.20).

The OSR ASK-LOM-AT Wizard

Step 8/24

LifeCycle: Contribute (Publisher)

Entity

Evlalia Amygdalaki

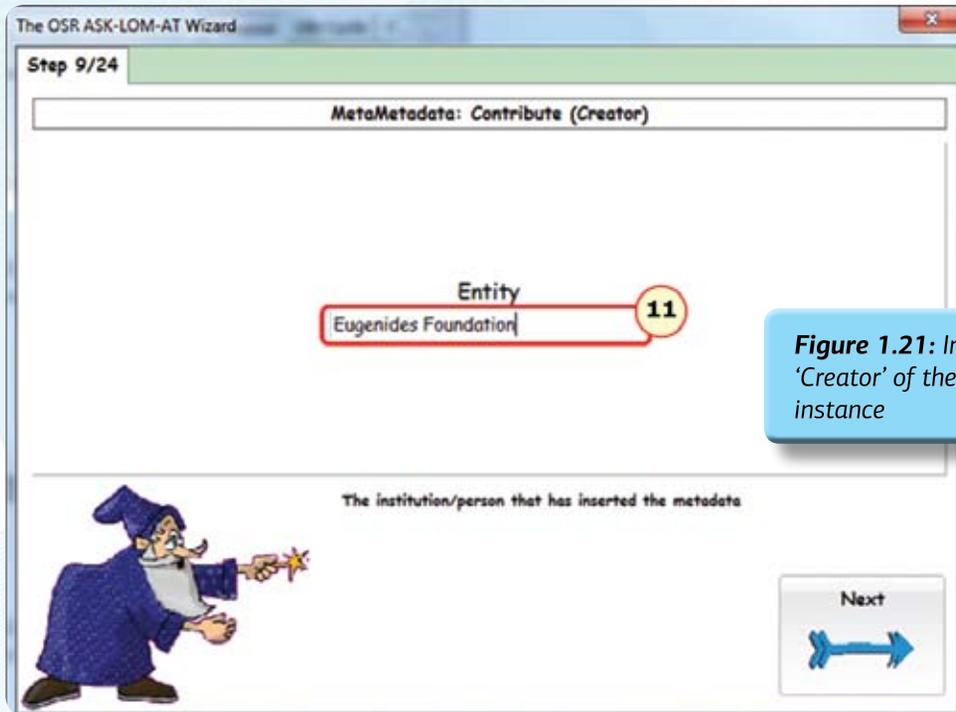
Delete Add

The institution/person that is providing/distributing the resource, e.g. the science museum/centre, the user who generated it

Next

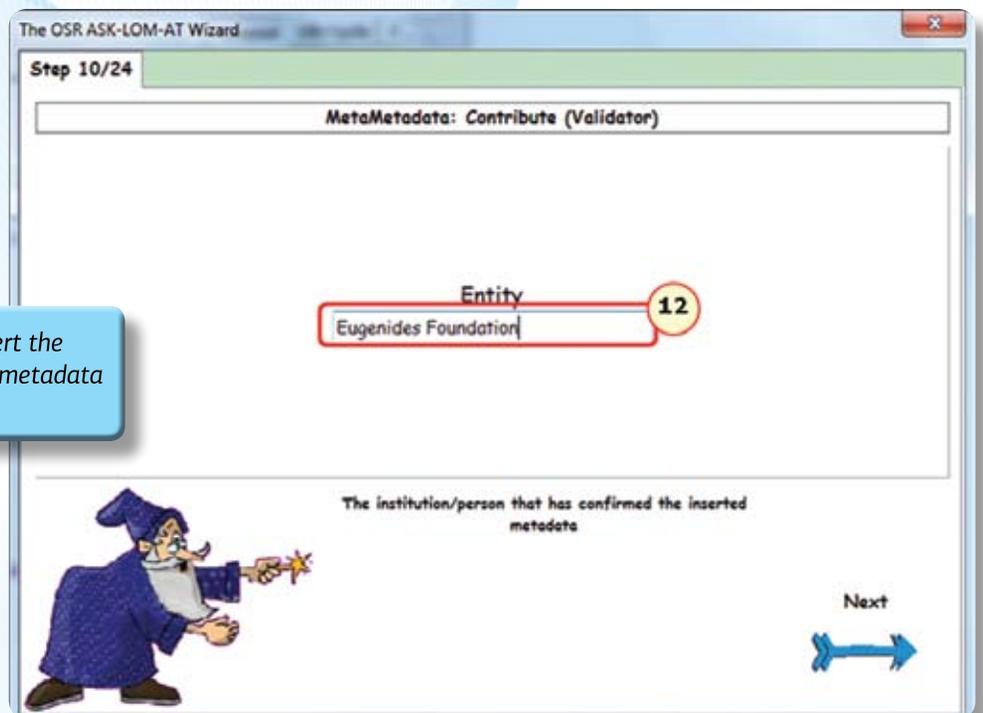
**Figure 1.20:** Insert the name of 'Publisher' of the learning object

11. Insert the name of the 'Creator', which created the metadata instance (see Figure 1.21).



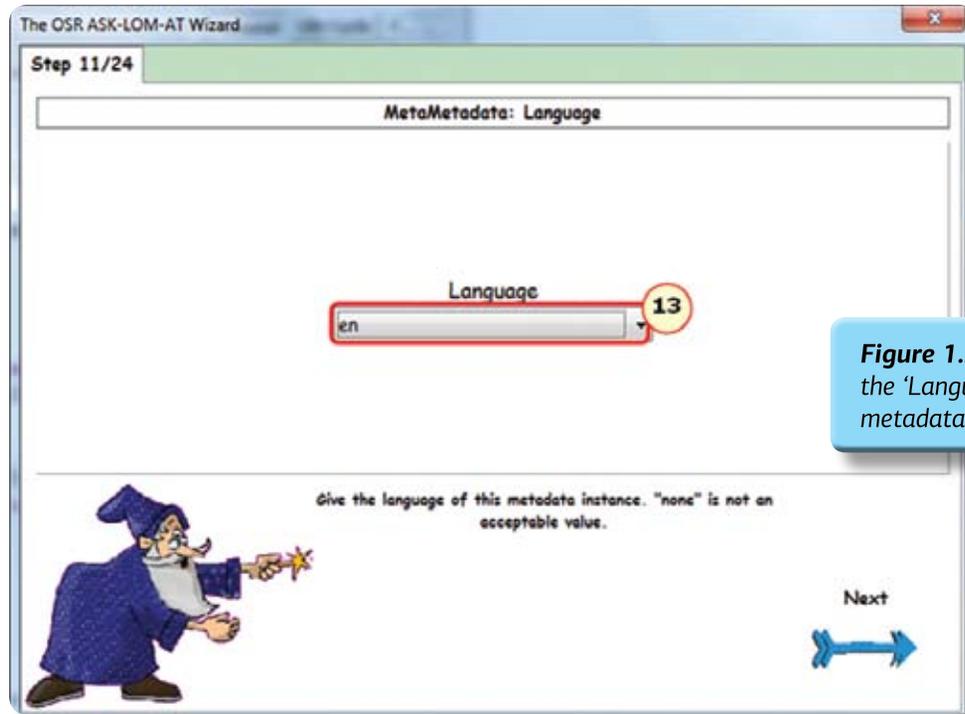
**Figure 1.21:** Insert the 'Creator' of the metadata instance

12. Insert the name of the 'Validator', which validated the metadata record (see Figure 1.22).



**Figure 1.22:** Insert the 'Validator' of the metadata instance

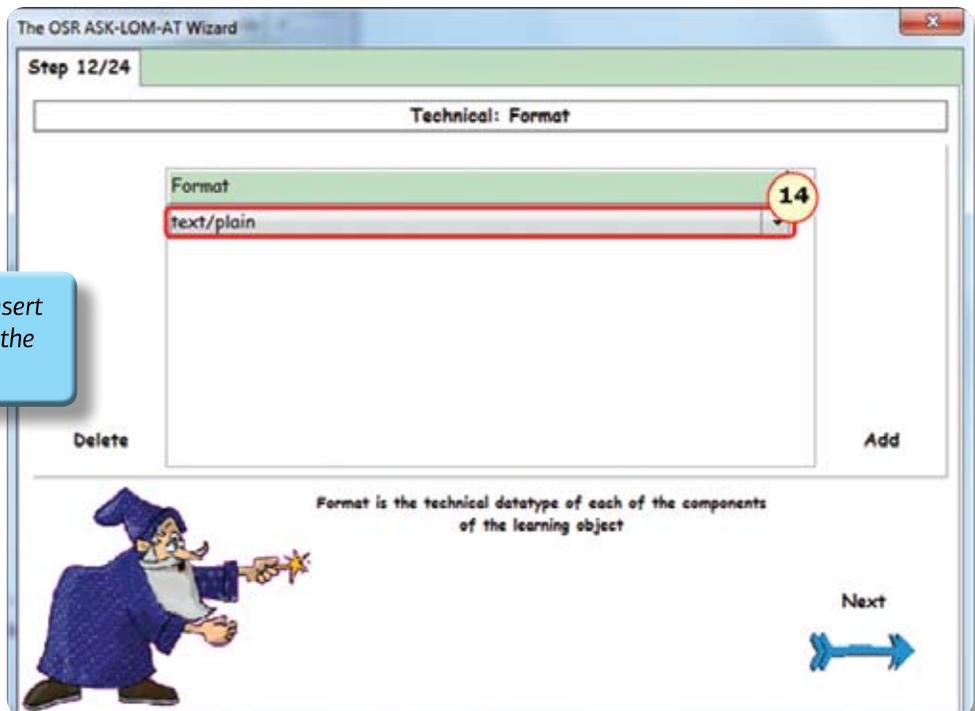
13. Insert the 'Language' of the metadata instance (see Figure 1.23).



The screenshot shows the 'OSR ASK-LOM-AT Wizard' window at Step 11/24. The title bar reads 'The OSR ASK-LOM-AT Wizard'. The main area is titled 'MetaMetadata: Language'. Below this, there is a 'Language' dropdown menu with 'en' selected. A red circle with the number '13' is placed over the dropdown arrow. At the bottom, there is a wizard character on the left, a text instruction: 'Give the language of this metadata instance. "none" is not an acceptable value.', and a 'Next' button with a blue arrow.

**Figure 1.23:** Insert the 'Language' of the metadata instance

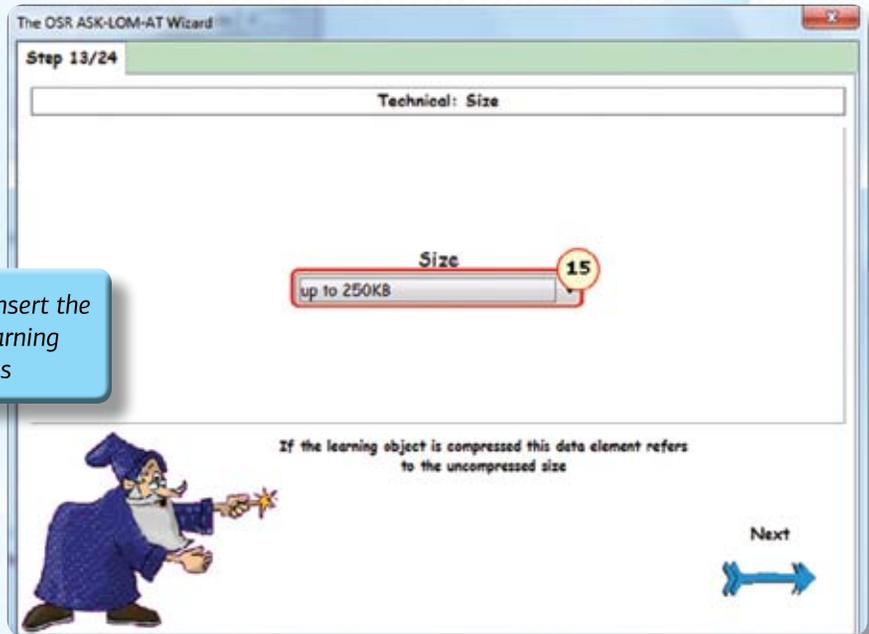
14. Insert the technical 'Format' of the learning object using the given list (see Figure 1.24).



The screenshot shows the 'OSR ASK-LOM-AT Wizard' window at Step 12/24. The title bar reads 'The OSR ASK-LOM-AT Wizard'. The main area is titled 'Technical: Format'. Below this, there is a list box containing 'text/plain'. A red circle with the number '14' is placed over the list box. At the bottom, there is a wizard character on the left, a text instruction: 'Format is the technical datatype of each of the components of the learning object', and a 'Next' button with a blue arrow.

**Figure 1.24:** Insert the 'Format' of the learning object

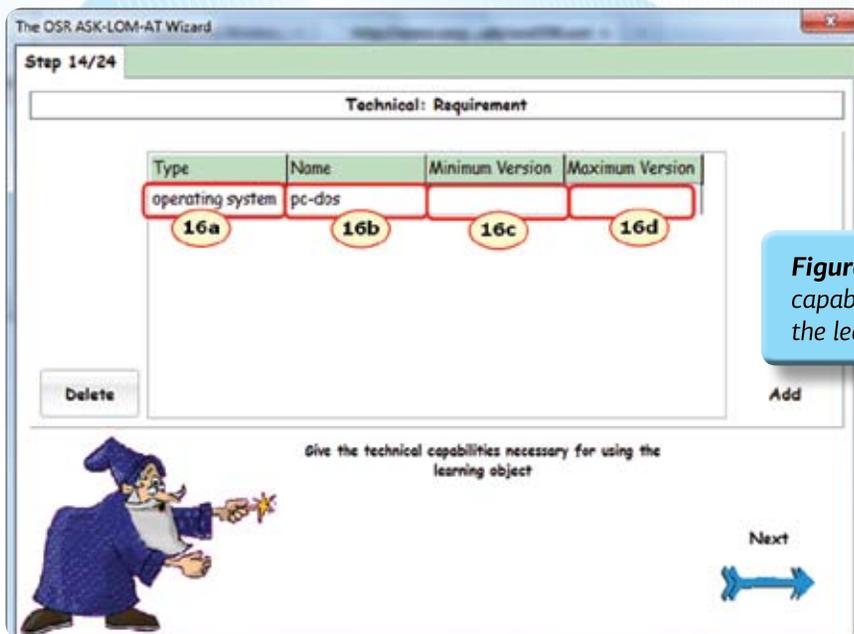
15. Insert the 'Size' of the learning object using the given list (see Figure 1.25).



**Figure 1.25:** Insert the 'Size' of the learning object in Kbytes

16. Insert the 'Technical Requirements' necessary for using this learning object (see Figure 1.26).

- Insert the '**Type**' of technology required for using the learning object, using the given list.
- Insert the '**Name**' of the required technology to use this learning object, using the given list.
- Insert the '**Minimum**' possible version of the required technology to use the learning object.
- Insert the '**Maximum**' possible version of the required technology to use the learning object.



**Figure 1.26:** Insert the technical capabilities necessary for using the learning object

17. Insert the 'Interactivity Type', 'Interactivity Level' and 'Difficulty' of the learning object (see Figure 1.27).
- Select the 'Interactivity Type', which specifies the predominant mode of learning supported by the learning object. The available choices are:
    - Active: "active" learning (e.g. learning by doing) is supported by content that directly induces productive action by the learner.
    - Expositive: "expositive" learning (e.g. passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through text, images or sound).
    - Mixed: when a learning object blends active and expositive interactivity types then the interactivity type is "mixed".
  - Select the 'Interactivity Level', which specifies the degree of interactivity of the learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behavior of the learning object. The available choices are: very low, low, medium, high, and very high.
  - Select the 'Difficulty', which specifies how hard it is to work with or through the learning object for the typical intended target audience. The available choices are: very easy, easy, medium, difficult and very difficult.

**Figure 1.27:**  
Select the 'Interactivity Type', the 'Interactivity Level' and the 'Difficulty' of the learning object

The OSR ASK-LOM-AT Wizard

Step 15/24

Educational: Interactivity Type + Level, Semantic Density and Difficulty

Interactivity Type 17a  
expositive

Interactivity Level 17b  
very low

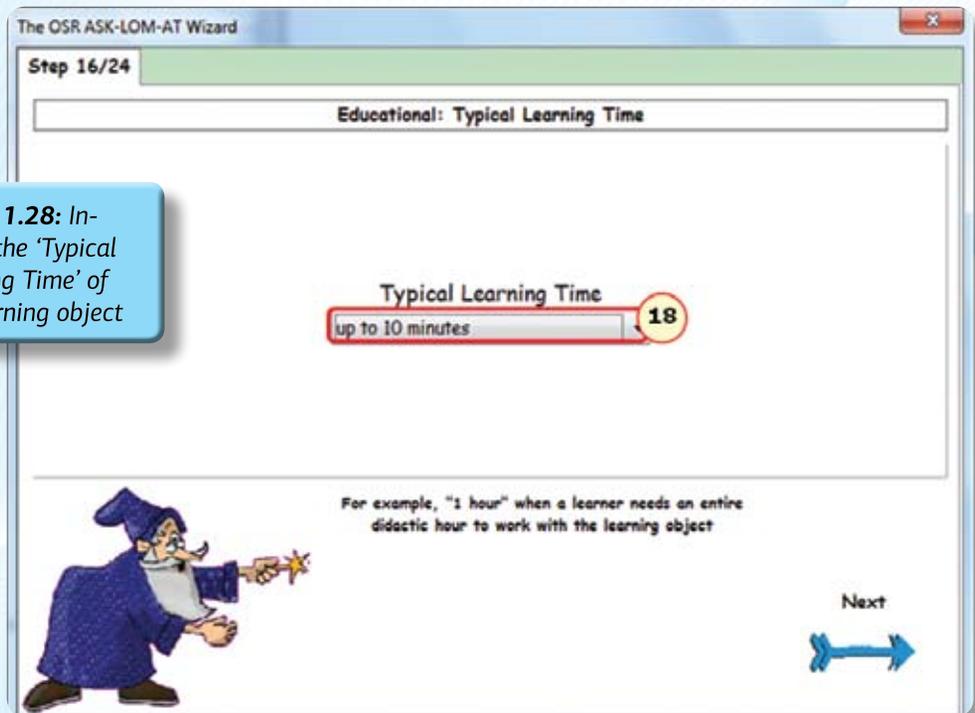
Difficulty 17c  
medium

How hard it is to work with or through this learning object for the typical target audience

Next

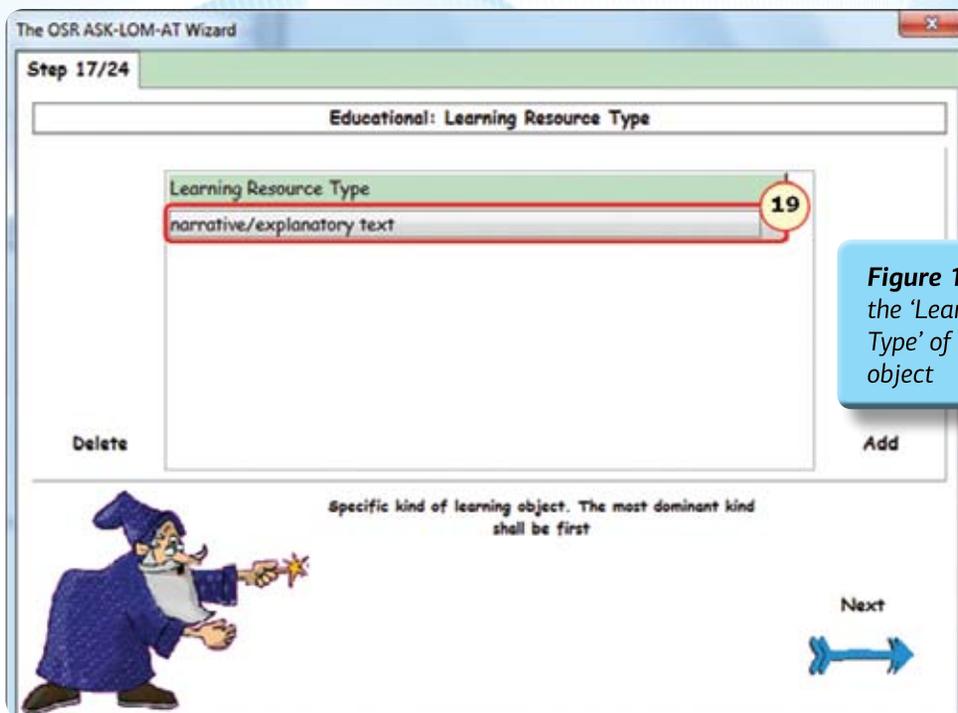
18. Indicate the 'Typical Learning Time' of the learning object using the given list (see Figure 1.28).

**Figure 1.28:** Indicate the 'Typical Learning Time' of the learning object



19. Select the 'Learning Resource Type' of the learning object, using the given list (see Figure 1.29).

**Figure 1.29:** Indicate the 'Learning Resource Type' of the learning object



20. Select the 'Intended End User Role' for the learning object, using the given list.

The OSR ASK-LOM-AT Wizard

Step 18/24

Educational: Intended End User Role

Intended End User Role

- teacher
- student
- occasional information collector
- other learner / visitor
- science museum educator

Delete

Add All

Add

Principal user(s) for which this learning object was designed, most dominant first

Next

**Figure 1.30:** Indicate the 'Intended End User Role' of the learning object

21. Select the 'Context' within which the learning and use of the learning object is intended to take place, using the given list (see Figure 1.31).

**Figure 1.31:** Indicate the 'Context' within which the learning and use of the learning object is intended to take place

The OSR ASK-LOM-AT Wizard

Step 19/24

Educational: Context

Context

- in the science museum/centre

Delete

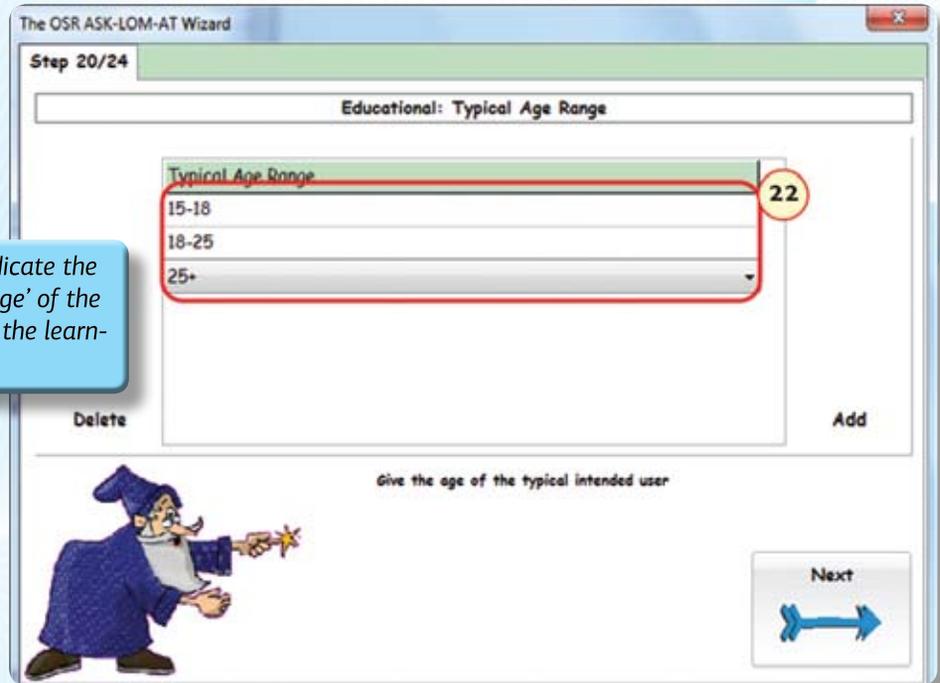
Add

The principal environment within which the learning and use of this learning object is intended to take place. Choose from the pre-defined list: school-connected (combined with one of the following two categories), in the science museum/centre (physical visit), on the web (virtual visit)

Next

22. Select the 'Typical Age Range' of the intended user of the learning object, using the given list (see Figure 1.32).

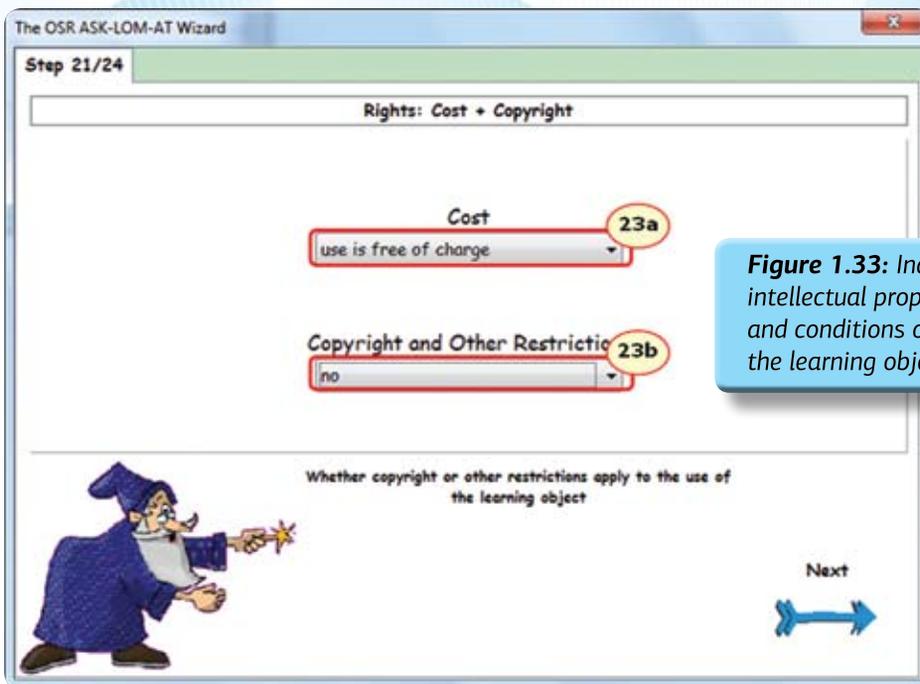
**Figure 1.32:** Indicate the 'Typical Age Range' of the intended user of the learning object



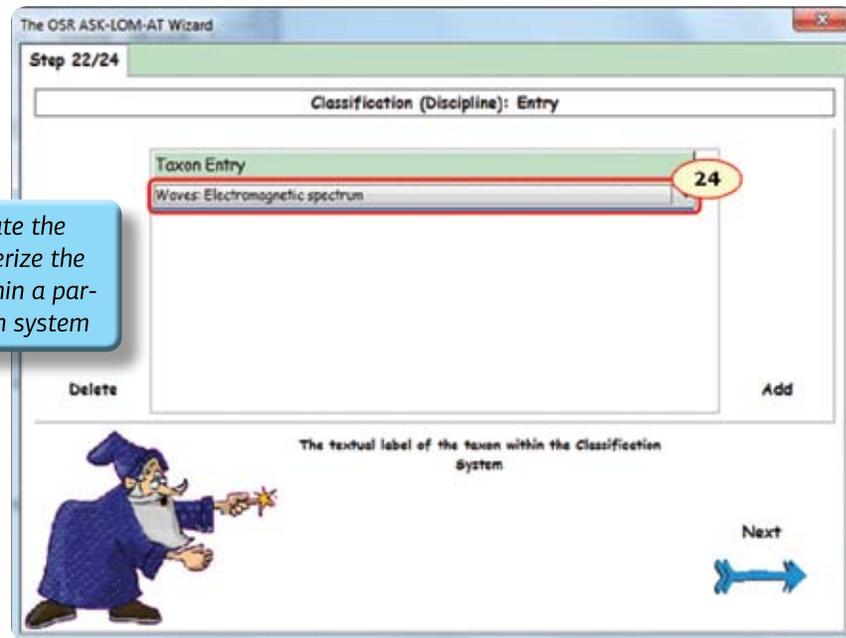
23. Indicate the intellectual property rights and conditions of use for the learning object (see Figure 1.33).

- a. Indicate whether the use of this learning object requires payment, using the given list.
- b. Indicate copyright or other restrictions apply to the use of the learning object , using the given list.

**Figure 1.33:** Indicate the intellectual property rights and conditions of use for the learning object



24. Indicate the terms that characterize the learning object within a particular 'Classification' system, using the given list.



**Figure 1.34:** Indicate the terms that characterize the learning object within a particular classification system

25. Indicate the educational objectives that the learning object is intended to achieve. The educational objectives are divided into four dimensions, as follows
- Cognitive Domain (Processes): This indicates the main intended cognitive process(es) in the learner as they use this resource. The classification of cognitive processes should be read as a 'scale' representing a gradual move from simple remembering towards higher-order thinking. Each level builds on and subsumes the previous levels. Choose a term from the pre-defined vocabulary list and provide a short open-text description expanding on the vocabulary item selected

The OSR ASK-LOM-AT Wizard

Step 23/26

Educational Objectives: Cognitive Domain (Processes)

Taxon ID	Taxon Entry
to remember	
to understand	
to apply	
to think critically and creatively	

Delete Add

Choose from the pre-defined vocabulary list: a) to remember: to help the learner recognize or recall information, b) to understand: to help the learner organize and arrange information mentally, c) to apply: to help the learner apply information to reach an answer, d) to think critically and creatively: to help the learner think on causes, predict, make judgments, create new ideas.

Next

**Figure 1.35: Indicate the educational objectives that the learning object is intended to achieve (Cognitive Domain -Processes)**

- b. Cognitive Domain (Knowledge): This indicates the type of knowledge the learner should gain through the use of this resource. Choose a term from the pre-defined vocabulary list and provide a short open-text description expanding on the vocabulary item selected

The OSR ASK-LOM-AT Wizard

Step 24/26

Educational Objectives: Cognitive Domain (Knowledge)

Taxon ID	Taxon Entry
▼	
factual knowledge	
conceptual knowledge	
procedural knowledge	
meta-cognitive knowledge	

Delete Add

Choose from the pre-defined vocabulary list: a) factual knowledge: knowledge of basic elements, e.g. terminology, symbols, specific details, etc b) conceptual knowledge: knowledge of interrelationships among the basic elements within a larger structure, e.g. classifications, principles, theories, etc c) procedural knowledge: knowledge on how-to-do, methods, techniques, subject-specific skills and algorithms d) meta-cognitive knowledge: knowledge and awareness of cognition, e.g. of learning strategies, cognitive tasks, one's own strengths, weaknesses and knowledge level

Next




25b

**Figure 1.36: Indicate the educational objectives that the learning object is intended to achieve (Cognitive Domain - Knowledge)**

- c. Affective Domain: This indicates the main interests, attitudes, opinions, values the learner should develop through the use of this resource. The classification of affective educational objectives should be read as a 'scale' representing a gradual move towards higher-order processes (from simple reception of stimuli through to values-based behaviour). Each level builds on and subsumes the previous levels. Choose a term from the pre-defined vocabulary list and provide a short open-text description expanding on the vocabulary item selected

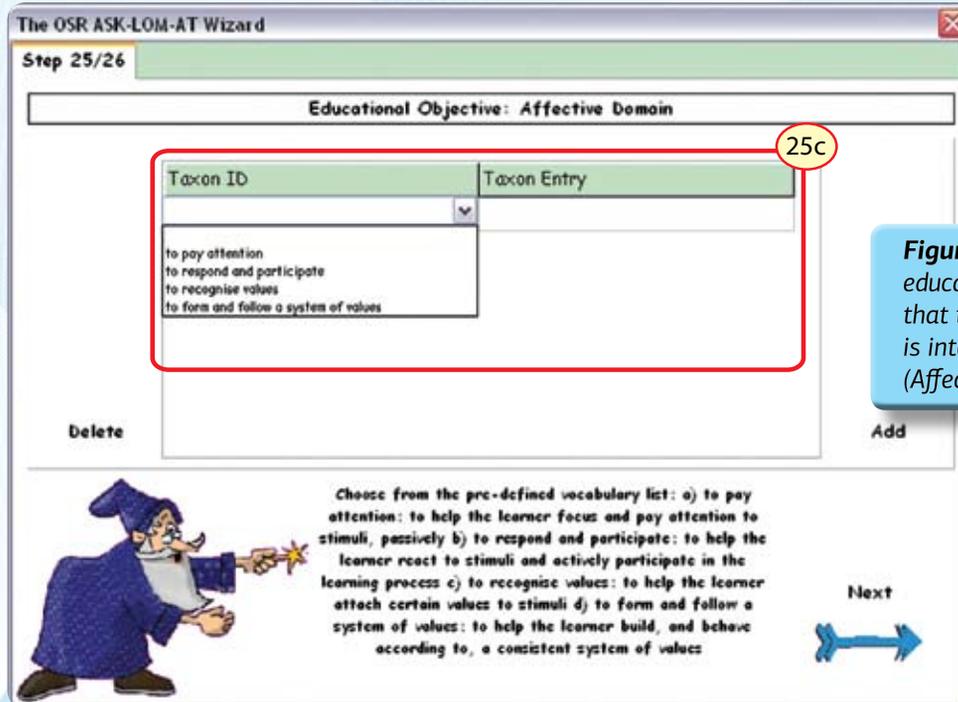


Figure 1.37: Indicate the educational objectives that the learning object is intended to achieve (Affective Domain)

- d. Psychomotor Domain: This indicates the movement and coordination skills the learner should develop through the use of this resource. The classification of psychomotor educational objectives should be read as a 'scale' representing a gradual move from the simplest behaviour to the most complex. Each level builds on and subsumes the previous levels. Choose a term from the pre-defined vocabulary list and provide a short open-text description expanding on the vocabulary item selected

The OSR ASK-LOM-AT Wizard

Step 26/26

Educational Objective: Psychomotor Domain

Taxon ID	Taxon Entry
<ul style="list-style-type: none"> <li>to imitate and try</li> <li>to perform confidently following instructions</li> <li>to perform independently, skilfully and precisely</li> <li>to adapt and perform creatively</li> </ul>	

Delete Add

Choose from the pre-defined vocabulary list: a) to imitate and try b) to perform confidently following instructions c) to perform independently, skilfully and precisely d) to adapt and perform creatively

Next



25d

**Figure 1.38:** Indicate the educational objectives that the learning object is intended to achieve (Psychomotor Domain)

26. Click 'Finish' to finalize metadata authoring process (see Figure 1.39).

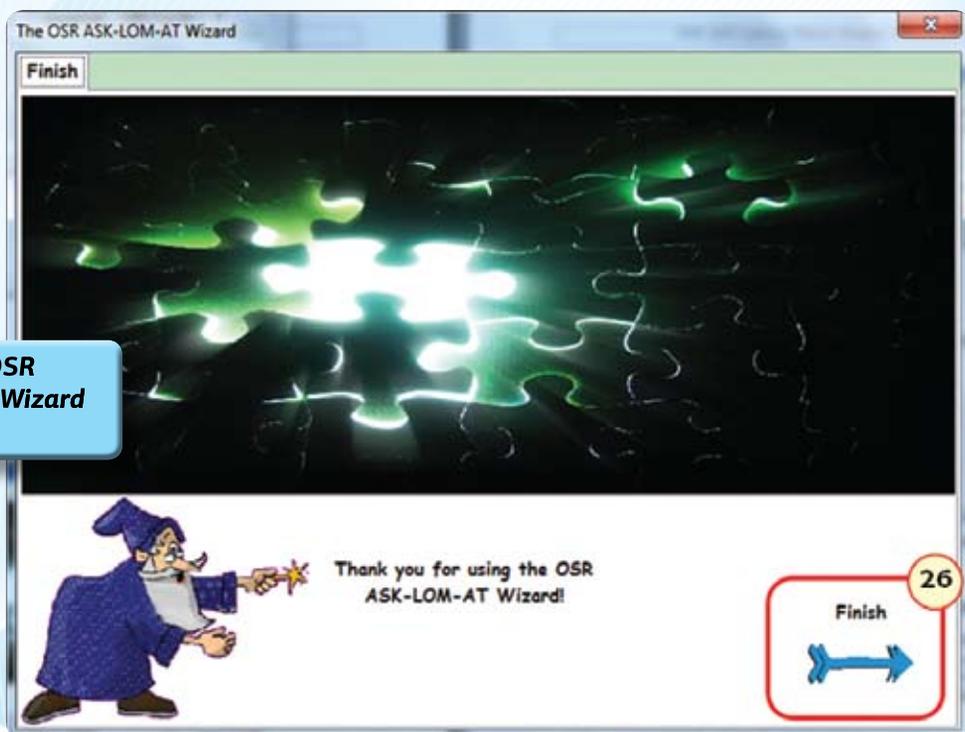
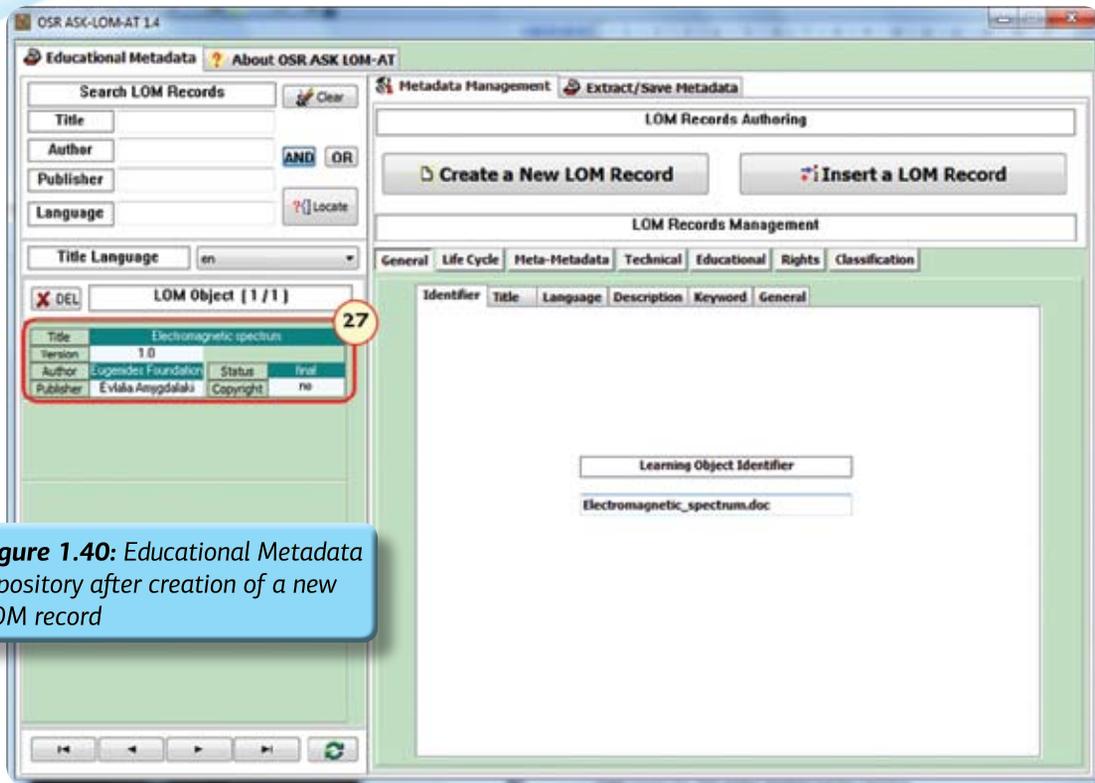


Figure 1.39: OSR ASK-LOM-AT Wizard finish

27. View the newly inserted metadata record in the local metadata repository (see Figure 1.40).

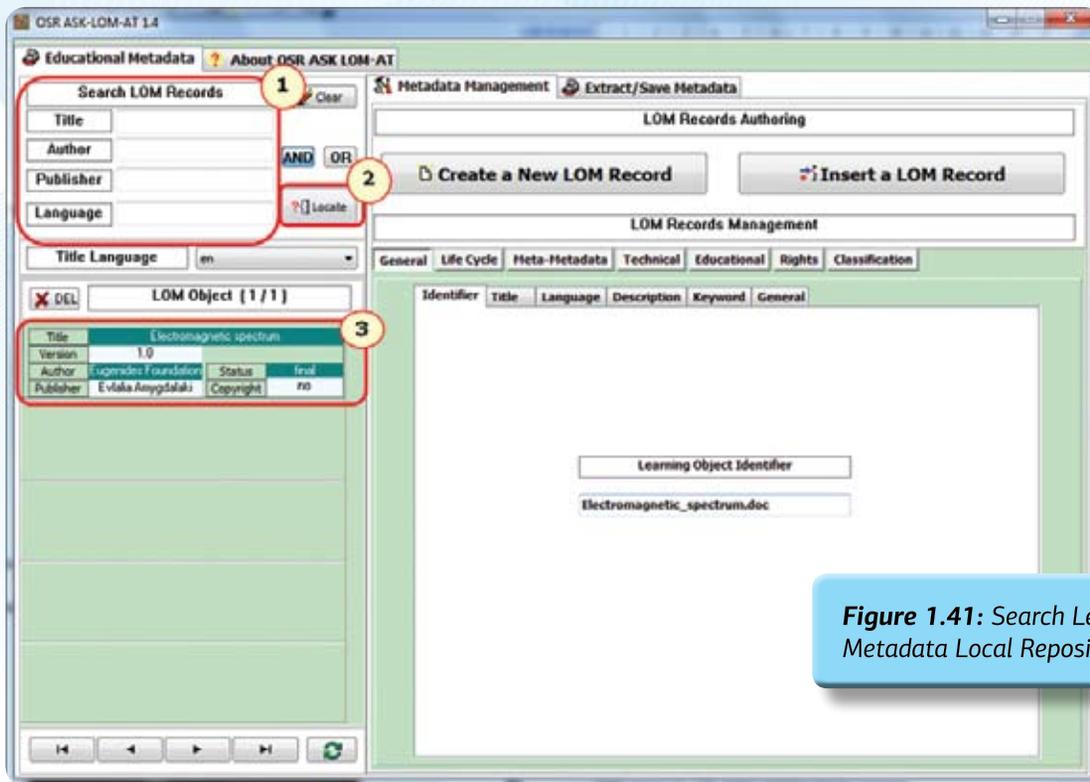


**Figure 1.40:** Educational Metadata repository after creation of a new LOM record

### 1.2.2 Search Learning Objects Metadata Local Repository

A user can search the local learning objects metadata repository, in order to locate desired metadata records. More specifically, the user can define specific keywords that he/she is looking for in the target learning object description, and in a number of selected metadata fields, namely the Title, Author, Publisher and the Language.

1. Insert your search criteria for the metadata record.
2. Press the “Locate” button.
3. View the metadata records results.

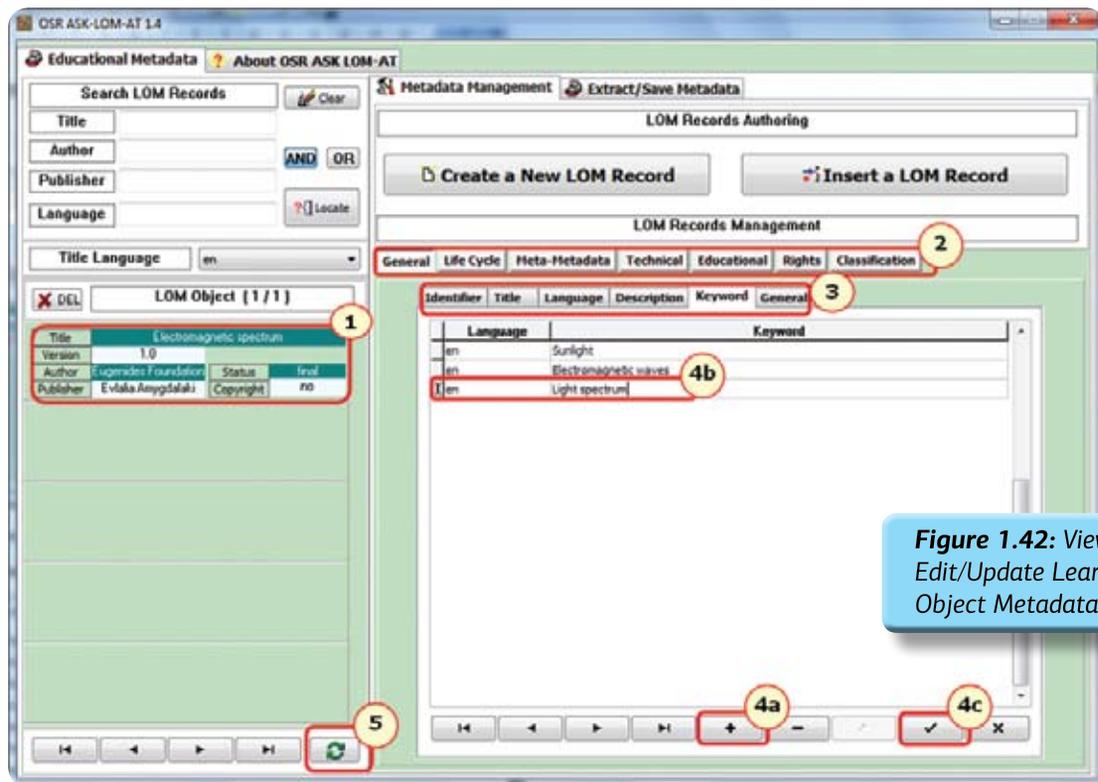


**Figure 1.41:** Search Learning Objects Metadata Local Repository

### 1.2.3 View or Edit/Update Learning Object Metadata

A user can view, edit or update any of the learning object metadata records that have been created and stored in the local metadata repository of OSR ASK-LOM-AT.

1. Select the metadata record you want to edit/update
2. Select the metadata category you want to edit/update
3. Select the metadata element within this category that you want to edit/update
4. Enter the new value.
  - a. Press the 'Insert Record' button
  - b. Enter the new value
  - c. Press the 'Post Edit' button
5. Press the 'Refresh' button.

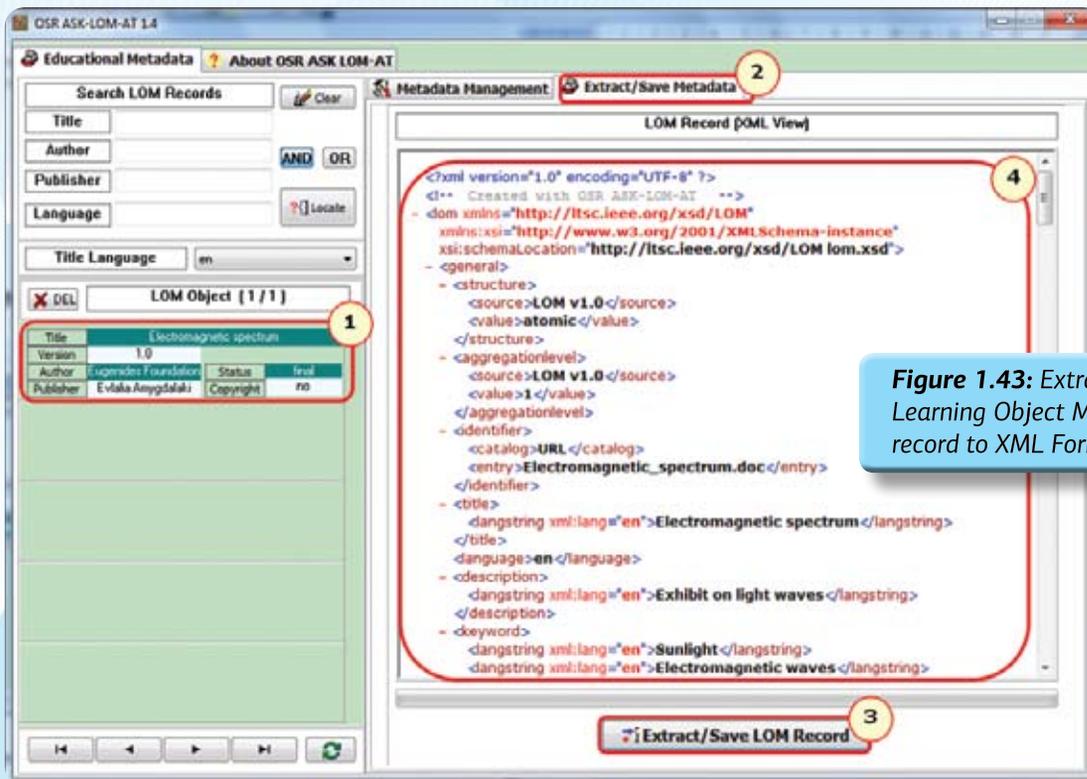


**Figure 1.42:** View and Edit/Update Learning Object Metadata

### 1.2.4 Extract Learning Object Metadata Record to XML Format

The 'Extract/Save Metadata' Tab allows for exporting the contents of individual learning objects metadata records as XML files. More specifically, it offers the exporting of a selected learning object's metadata record as a single XML file that conforms with the IEEE LOM standard.

1. Select the metadata record you want to export
2. Select the 'Extract/Save Metadata' Tab
3. Press the 'Extract/Save LOM Record' Button
4. The XML representation of the learning object metadata record will be presented

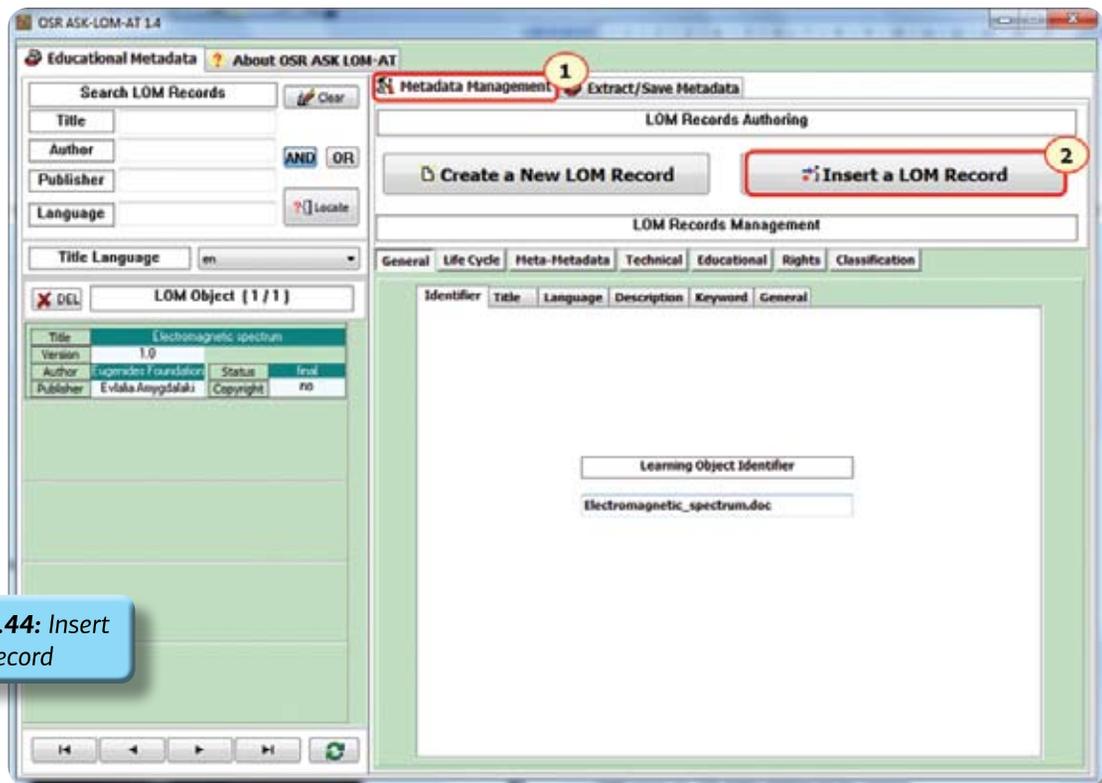


**Figure 1.43:** Extract Learning Object Metadata record to XML Format

### 1.2.5 Import Learning Object Metadata Record

The 'Insert a LOM Record' button allows for importing the contents of individual learning objects metadata records, conformant with the OSR IEEE LOM Science Education Application Profile, into the OSR ASK-LOM-AT Local Metadata Repository. This feature, is not part of the Learning Object Metadata authoring process, however, it is useful when a user wants to edit/update a metadata record that is not saved in the Local Metadata Repository of OSR ASK-LOM-AT.

1. Select the 'Metadata Management' Tab
2. Press the 'Insert a LOM Record' button
3. The new learning object metadata record is added to the Local Metadata Repository



**Figure 1.44:** Insert a LOM Record

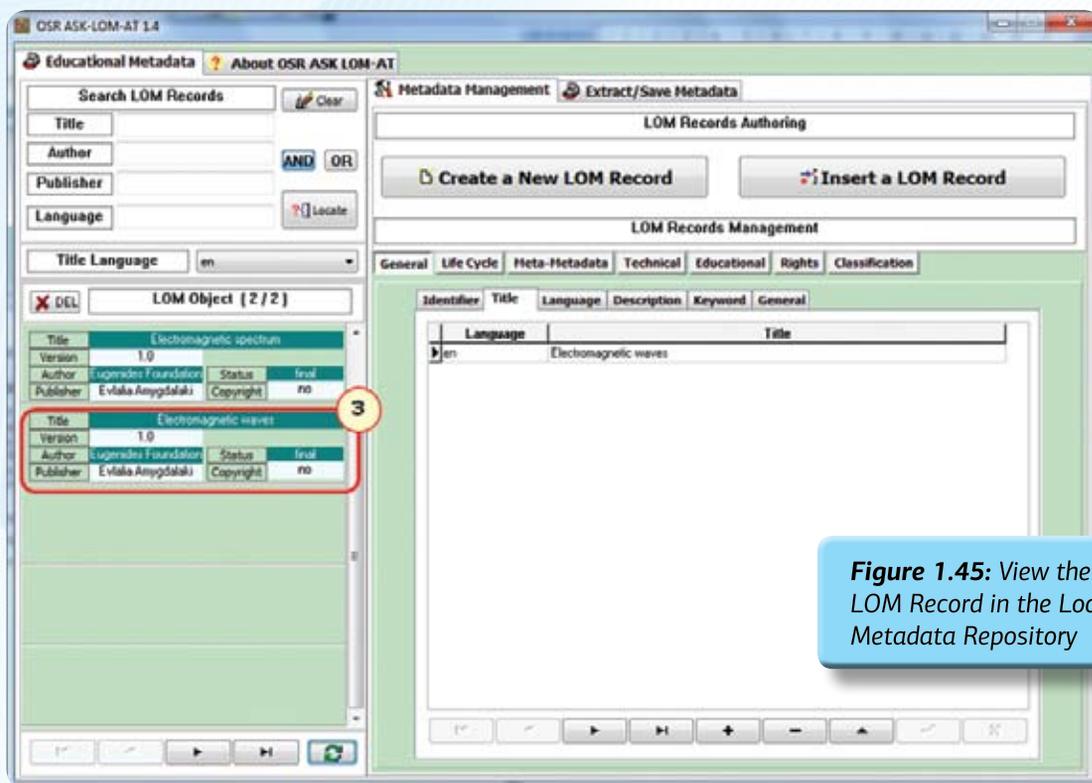


Figure 1.45: View the new LOM Record in the Local Metadata Repository

## 2 Indicative Examples for Educational Metadata Characterization

In this chapter, some indicative examples for educational metadata characterization are presented. More specifically, in Section 2.1 two indicative examples for educational metadata characterization of Science Education Resources are presented and in Section 2.2, one indicative example for educational metadata characterization of an Educational Pathway is presented.

### 2.1 Science Education Resources Characterization Examples

#### 2.1.1 How can one observe the Earth's rotation?

The Science Education Resource presented below (Figure 2.1), is called “How can one observe the Earth's rotation?” and it is an explanatory text describing how the earth's rotation can be observed. Table 2.1 presents the educational metadata for this resource.

### How can one observe the Earth's rotation?

**Visit**

A more objective experiment than observations made by human senses is needed in order to come to any conclusions about the movement of the earth. In 1851 the French scientist [Léon Foucault](#) presented his pendulum which could turn freely because of the ingenious way it was constructed. A similar pendulum is on display in the science center Neureka.

**Children's normal swing** with 2 chains or arms is a pendulum, which has a fixed swinging plane regarding to the earth. So when earth rotates, swinging plane of the swing has to rotate too. The movement is so slow, that swinger can not feel the force, which turns the swinging plane.



[Foucault pendulum, which is for instance in Neureka](#) (YouTube)

[Foucault pendulum, which is for instance in Neureka](#) (OSR)

has a different construction. The arm (4) of the pendulum in Neureka can swing in a vertical direction around the axle (1) and also in a horizontal direction around the attachment to the ceiling (3), aided by the bearings (2). A shaft of this kind is called a Cardan shaft according to its inventor, Santiamo Cardano. Somewhat similar constructions are used in the transmission of rear-wheel cars. Nice model of Foucault pendulum can be made from Lego blocks. It is easy to study the function of pendulum with this miniature model.

As the pendulum strives to maintain the direction in which it is swinging, the direction seems to swing clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere. The reason for this is that the Earth revolves "counter-clockwise" - from the west to the East - and thus

an object maintaining a constant motion seems to shift to the opposite direction, i.e. clockwise in the Northern Hemisphere.

[So when a visitor sees Neureka's swing turn clockwise he actually sees Earth rotate counter-clockwise.](#)

It is also possible to make more or less rough calculations from the swinging of the Foucault's pendulum.

The relation between pendulum's arm's length ( $l$ ) and time of swing ( $T$ ) is  $T = \frac{2\pi \cdot l}{\sqrt{g}}$ , where  $g$  is  $9.81 \text{ m/s}^2$  is acceleration of earth's gravity.  $T$  is the time of backward-and-forward swing.

If visitor measures the time for instance 10 backward-and-forward swings, it is possible to get rather good average value for one swing. From the formula one can calculate the height of the hall. At either the [North Pole](#) or [South Pole](#), the plane of oscillation of a pendulum remains fixed with respect to the [fixed stars](#) while Earth rotates underneath it, taking one [general day](#) to complete a rotation. So relative to Earth, the plane of oscillation of a pendulum at the North or South Pole undergoes a full clockwise or counter clockwise rotation during one day, respectively. When a Foucault pendulum is suspended on the [equator](#), the plane of oscillation remains fixed relative to Earth. At other latitudes, the plane of oscillation precesses relative to Earth, but a slower than at the pole; the angular speed,  $\omega$  (measured in clockwise [degrees](#) per [minutes of day](#)), is proportional to the [sine](#) of the [latitude](#), or:

$$\omega = \sin \varphi$$

here, latitudes north and south of the equator are defined as positive and negative, respectively. For example, a Foucault pendulum in Neureka at 60° north latitude, viewed from above by an earthbound observer, rotates clockwise 312° in one day. Of course, if air resistance and friction would stop it before that.

In Neureka it is possible to measure, how much the pendulum turns in certain time. This way it is easy to check, if the formula above is correct. For instance in 8 minutes the pendulum should turn ca. 2°. The blades, which show the phenomenon, are about 1,5 m from the center. So the displacement is:

$$150 \cdot \tan(2^\circ) = 2,5 \text{ cm.}$$


**Figure 2.1:** The Science Education resource “How can one observe the Earth's rotation?”

## Guidelines for the Design of Technology-Enhanced Science Education Learning Content

General		
Identifier	foucault_visit_OSJ.doc	
Title	Observing Earth's rotation	
Language	en	
Description	How can one observe the Earth's rotation?	
Keyword(s)	Earth's rotation, Foucault pendulum	
Structure	Atomic	
Aggregation Level	Educational Content	
Life Cycle		
Author	HEUREKA	
Publisher	Timo Suvanto	
Meta-Metadata		
Creator	Timo Suvanto	
Validator	Timo Suvanto	
Language	En	
Technical		
Format	application/word processing	
Size	From 1MB to 5MB	
Requirements	Type	-
	Name	-
	Minimum Version	-
	Maximum Version	-
Educational		
Interactivity Type	Active	
Learning Resource Type	narrative/explanatory text	
Interactivity Level	Low	
Intended User Role	Student	
Context	School-connected	
Typical Age Range	15-18, 18-25, 25+	
Difficulty	difficult	
Typical Learning Time	Up to 2 hours	
Rights		
Cost	use is free of charge	
Copyright and Other Restrictions	yes	
Classification (Discipline)		
Entry	Astronomy: Earth Forces and motion: Foucault pendulum Forces and motion: Rotation	
Entry	Classification Educational Objective-Cognitive (Processes) to understand	
Entry	Classification Educational Objective-Cognitive (Knowledge) conceptual knowledge	
Entry	Classification Educational Objective-Affective to respond and participate	
Entry	Classification (Educational Objective-Psychomotor) to imitate and try	

**Table 2.1:** Metadata for the Science Education resource "How can one observe the Earth's rotation?"

### 2.1.2 Discovery of nuclear fission

The Science Education Resource presented below (Figure 2.2), is called “Discovery of nuclear fission” and it is an image of the Nuclear fission experimental setup, reconstructed at the Deutsches Museum. Table 2.2 presents the educational metadata for this resource.



**Figure 2.2:** The Science Education resource “Discovery of nuclear fission”

## Guidelines for the Design of Technology-Enhanced Science Education Learning Content

General		
Identifier		800px-Hahnmeitnerstrassmann.jpg
Title		Nuclear fission
Language		en
Description		Nuclear fission experimental setup, reconstructed at the Deutsches Museum, Munich
Keyword(s)		Nuclear fission
Structure		Atomic
Aggregation Level		Educational Content
Life Cycle		
Author		Deutsches Museum
Publisher		Sofoklis Sotiriou
Meta-Metadata		
Creator		Deutsches Museum
Validator		Sofoklis Sotiriou
Language		en
Technical		
Format		image/jpeg
Size		From 500KB to 1MB
Requirements	Type	Browser
	Name	Ms-internet explorer
	Minimum Version	6
	Maximum Version	8
Requirements	Type	Operation System
	Name	MACOS
	Minimum Version	10
	Maximum Version	12
Educational		
Interactivity Type		Active
Learning Resource Type		Diagram/graph/chart/plot
Interactivity Level		High
Intended User Role		Teacher Student
Context		In the science museum/centre
Typical Age Range		12-15, 15-18, 18-25, 25+
Difficulty		medium
Typical Learning Time		Up to 1 hour
Rights		
Cost		use is free of charge
Copyright and Other Restrictions		yes
Classification (Discipline)		
Entry		Tools for science: Laboratory equipment – generally Energy: Radiation History of Science and Technology: Scientists and inventors Radioactivity: Nuclear fission
Classification Educational Objective-Cognitive (Processes)		
Entry		to understand
Classification Educational Objective-Cognitive (Knowledge)		
Entry		conceptual knowledge
Classification Educational Objective-Affective		
Entry		to respond and participate
Classification (Educational Objective-Psychomotor)		
Entry		to adapt and perform creatively

**Table 2.2:** Metadata for the Science Education resource “Discovery of nuclear fission”

## 2.2 Educational Pathway Characterization Example

### 2.2.1 Foucault pendulum Open Pathway

The Educational Pathway presented (Figure 2.3) is called “Foucault pendulum” and it is a collection of learning objects related to Foucault pendulum. Table 2.3 presents the metadata for this Educational Pathway.

The screenshot displays the OpenScienceResources website interface. At the top, the logo reads "OpenScienceResources" with the tagline "merging science & knowledge". Below the logo is a navigation bar with the text "CONNECT Construct your Educational Pathway" and a link "Links to: Connect&OSR Portal". The main content area shows a navigation menu with four items: "Introduction The guidance", "Pre-visit activities preparing for the education", "Visit creation, discussion" (which is highlighted), and "Post-visit discussion, reflection, feedback". Under the "Visit" section, there is a heading "The core experience" followed by a paragraph: "This is a collection of learning objects related to Foucault pendulum. The learning objects are published in the OSR Portal." Below this, a bulleted list of learning objects is provided:

- [Foucault's Pendulum](#)
- [Interactive image of the Foucault pendulum at Deutsches Museum](#)
- [Foucault pendulum made from Lego blocks](#)
- [Foucault pendulum in Heureka](#)
- [A short historical account on the Foucault pendulum and the gyroscope](#)

At the bottom of the page, there is a small logo and the text "best viewed by firefox".

**Figure 2.3:** The Science Education structured pathway “Foucault pendulum”

General		
Identifier	<a href="http://www.osrportal.eu/~osrgr/connect.php?m=viewer&amp;nid=93764">http://www.osrportal.eu/~osrgr/connect.php?m=viewer&amp;nid=93764</a>	
Title	Foucault pendulum Open Pathway	
Language	en	
Description	This is a collection of learning objects related to Foucault pendulum	
Keyword(s)	Pendulum, Rotation, Oscillation	
Structure	Collection	
Aggregation Level	Educational Pathway	
Life Cycle		
Author	Ellinogermaniki Agogi	
Publisher	Sofoklis Sotiriou	
Meta-Metadata		
Creator	Sofoklis Sotiriou	
Validator	Sofoklis Sotiriou	
Language	en	
Technical		
Format	text/html	
Size	Not intended for download	
Requirements	Type	browser
	Name	Netscape communicator
	Minimum Version	-
	Maximum Version	-
Educational		
Interactivity Type	Mixed	
Learning Resource Type	Open Pathway	
Interactivity Level	Medium	
Intended User Role	Teacher Student Other learner/visitor	
Context	On the web	
Typical Age Range	15-18	
Difficulty	Easy	
Typical Learning Time	Up to 1 hour	
Rights		
Cost	Use is free of charge	
Copyright and Other Restrictions	No	
Classification (Discipline)		
Entry	Forces and motion: Foucault pendulum	
	Classification Educational Objective-Cognitive (Processes)	
Entry	to understand	
	Classification Educational Objective-Cognitive (Knowledge)	
Entry	conceptual knowledge	
	Classification Educational Objective-Affective	
Entry	to respond and participate	
	Classification (Educational Objective-Psychomotor)	
Entry	to imitate and try	

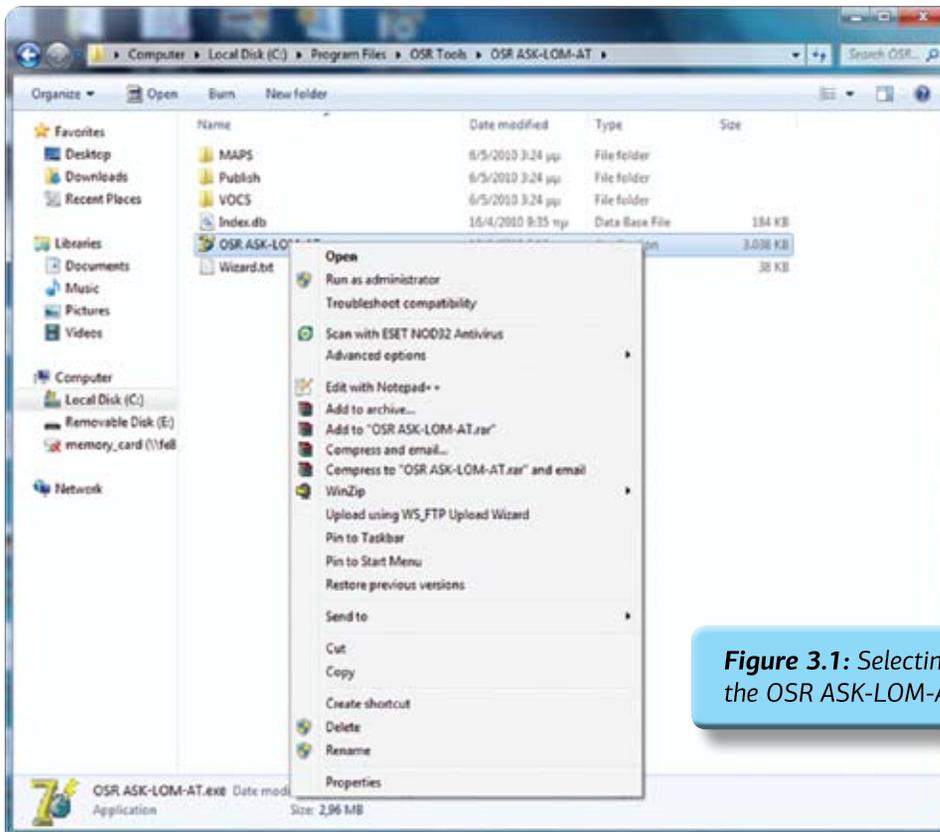
**Table 2.3:** Metadata for the Educational Pathway “Foucault pendulum Structured Pathway”

### 3 Annexes

#### Annex 1: Guidelines on How to Install OSR ASK-LOM-AT on Widows VISTA and Windows 7

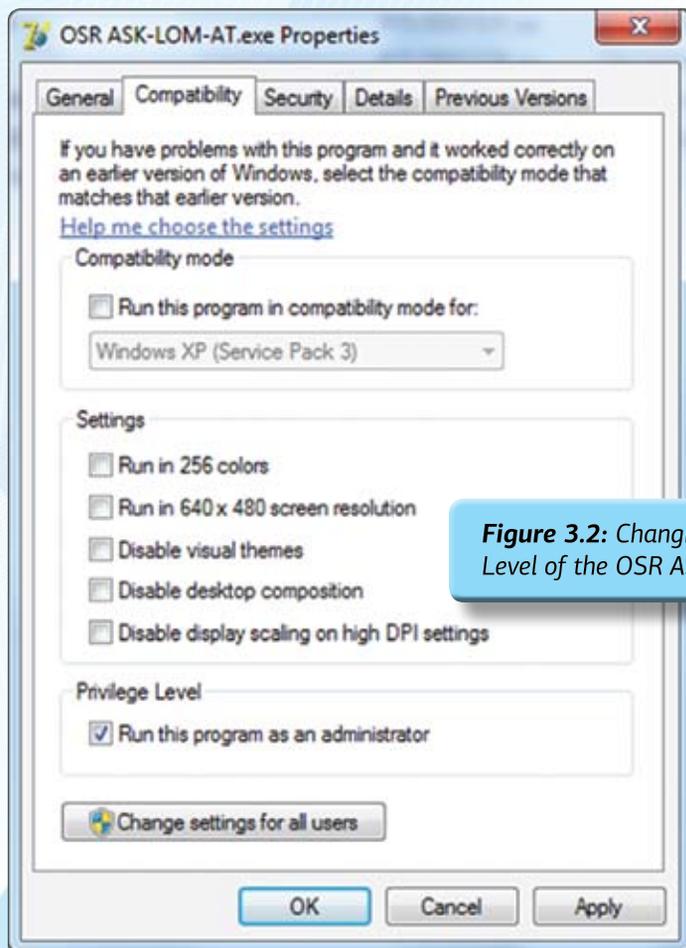
In order to install the OSR ASK-LOM-AT the user should create an administrator account. After the installation the OSR-ASK-LOM-AT can run from a non-administrator account if the steps below will be followed:

1. From the file C:\Program Files\OSR Tools\OSR ASK-LOM-AT\OSR ASK-LOM-AT.exe right click and select Properties.



**Figure 3.1:** Selecting the Properties of the OSR ASK-LOM-AT.exe File

2. Then select Compatibility tab and select the check box “Run this program as an administrator”. After this change you can start again the OSR ASK-LOM-AT and it should start normally.



**Figure 3.2:** Changing the Privilege Level of the OSR ASK-LOM-AT.exe File

## Annex 2: Technical Requirements of OSR ASK-LOM-AT

The OSR ASK-LOM-AT has been developed in Borland Delphi and can run in Microsoft Windows 98/Me/NT/2000/XP/2003/Vista/ and Windows 7.

The minimum system requirements for the execution of the OSR ASK-LOM-AT tool are:

- Processor: 400 MHz Intel Pentium Celeron or AMD Duron
- Memory RAM: 64 MB
- Input Devices: Keyboard, Mouse
- Hard Disk: 25 MB for the installation and other space for user files
- Monitor Colors: True Color (32 bit)

The recommended system requirements for the execution of the OSR ASK-LOM-AT tool are:

- Processor: 800 MHz Intel Pentium III or AMD Athlon
- Memory RAM: 128 MB
- Input Devices: Keyboard, Mouse
- Hard Disk: 25 MB for the installation and other space for user files
- Monitor Colors: True Color (32 bit)

