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LiLa – Library of Labs

Annex 4 to D1-A: Additional Deliverable: Tutoring System Report

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¹ OJ L 79, 24.3.2005, p. 1.



1 Introduction

In the pedagogical report (Deliverable 3.2) we described how effective learning takes place nowadays. Posting content will only be effective within a larger motivational and interactive context. Having a collection of experiments and materials is a prerequisite, but not sufficient for learning. Students also need structured material, guidance or help through experts and collaboration with other learners. The idea is to use the tutoring system already developed for the virtual laboratory of the University of Stuttgart to support students in learning within the LiLa portal. As already described in the Tutoring System report (Deliverable 3.1) the existing tutoring system has some problems: the high effort for setting up new courses, the close linking to the virtual lab VideoEasel, and the restricted pedagogical approach underlying the tutoring system.

Fact is that online teaching requires at least as much effort by a human teacher as classroom teaching. The teacher must motivate and guide each student through interaction and a sense of social presence. While much of this interaction will take place in local Learning Management Systems of the universities, we want to support this kind of interaction on the LiLa portal as well with social tools on the one hand and a new kind of tutoring system on the other.

As already described in the pedagogical report (Deliverable 3.2 – chapter 6 “Characteristics of effective learning environments”) effective learning environments must be learner, knowledge, assessment and also community centered. We want to achieve this challenge with a new concept for a tutoring system. With the mentioned paradigms the term “tutoring system” seems inadequate and will be replaced by “LiLa learner support system”.

The main idea is to support the students in learning in a way which follows the four items of effective learning environments. The portal should allow the teacher to build learner, knowledge, assessment and community centered content.

- Learner centered environments attempt to help students make connections between their previous knowledge and their current academic task. Therefore teachers should become familiar with each student’s special interests and strengths. This is not that easy in an online environment. An instrument for the teacher to get in touch with their student’s, which means that they could become more familiar with them, will be the social tools integrated in the LiLa portal. Another instrument to support the individual student will be the lesson concept in the LiLa portal which allows the teacher to build lessons with different learning paths regarding their previous knowledge and their way to learn.
- Effective environments must also be knowledge centered. A knowledge centered environment helps the students to develop interconnected pathways within a discipline so that they “learn their way around in it” and not lose sight of where they are. The LiLa lesson concept takes this into account with the transparency of the structure of a lesson for the students and the possibility for the students to choose their own way through the lesson.
- Issues of assessment also represent an important perspective for viewing the design of learning environments. Feedback is fundamental on learning. Summative assessments that occur at the end of projects are not sufficient, also needed are formative assessments that provide students opportunities to revise and hence improve the quality of their thinking and learning. With the possibility to include assessments into



a LiLa lesson, combined with teaching guides where we describe how a “good” assessment will look like and support teacher in developing good assessments, this perspective on the design of learning environments will be taken into account.

- Community centered means that students can build a community of learners by using social tools like forums, comments, rating and so on. These social tools provide also the possibility of a peer-to-peer tutoring approach which might help students to get through the learning process by helping each other.

That means that inside the LiLa Portal the students have more than only a collection of material and a functionality to search within this material. Teachers should be able to structure specific material and to build a lesson which can be used by the students, and students should be supported when performing their lessons. This environment will substitute the previous tutoring system and will be described in detail in the following sections.

First we will describe the new Learner Support Concept in general and then give a detailed example using mockups to illustrate how the learner support will look like within the LiLa portal. Please notice that this is not yet the real design of the portal, furthermore these are first examples to illustrate the idea and the functionality of the lesson concept and the learner support of the LiLa portal.

2 The Learner Support Concept

The teacher must have the possibility to set up whole lessons within the LiLa portal regarding the issue that he or she wants to support his or her students in a motivating and interactive way. For that we need an environment which in turn supports the teacher to set up lessons as easy as possible.

The LiLa Metadata Profile describes the pedagogical metadata and takes lessons and activities into account as follows (LiLa Metadata profile section 3.1.2.1 and 3.1.2.2):

Activities:

“Activities are the basic building block to structure the technical components. They allow a teacher to align experiments and other media files into a structure that can be used by somebody to learn something about a specific topic. They are themselves used as basic blocks of lesson. Two typical activities would be *Introduction* and *Assignment*. The introduction would group together elements that would provide an introduction of a specific topic to a learner. An assignment would contain elements like a description of a task, an experiment to conduct and some questions to answer with the help of the experiment. “

Lessons:

“The last building block of the system is the lesson. Their purpose is allowing teacher to group activities into entire lessons concerning a given topic. While activities provide the learner with a self-contained activity like provide an introduction, the lesson will provide him or her with one or more paths through a certain subject containing different activities like an introduction followed by one or more assignments and end with a final assessment. The LiLa Portal itself contains a tutoring system, which provides the user with an easy to use interface to follow his or her path through a lesson.”



The metadata model already describes the lesson as a collection of activities. These activities or more precisely learning activities can be arranged in a specific structure. Here are some examples for different kinds of lessons, depending on their different structure:

- A simple collection of material which explains a certain topic.
- A lesson which has an experiment as its main topic similar to a real lab course where students have to write a report on the experiment and its outcomes.
- A lesson with a complex structure: The lesson has different learning paths – like a graph – and the student's way through the lesson depends on his or her knowledge or preferences.

For developing these different kinds of lessons we developed an editor for supporting lesson creators. This editor is integrated into the LiLa portal and supports various learning activities. A learning activity is a building block in a larger pedagogical scenario, which is in our case the lesson to be created. Going beyond these definitions in the metadata definition, we further classify activities as follows:

- **Introduction:**
The introduction is a text/media object introducing the subject of the lesson and providing its theoretical context. The introduction should be kept as simple as possible, some text with supporting graphics or an introductory video is sufficient.
- **Assignment:**
An assignment is a kind of recipe of an exercise. It can range from individual to group assignments. An assignment provides students with a description to do something alone or with others and will in our context mostly concern experiments... It tells the students to find out something or gives them a problem which they can solve performing the experiment. Assignments activate students. For assignments the lesson editor offers the possibility to type text, to upload additional material (media packages), to add links and graphics.
- **Assessment:**
With an assessment, a student can test or reflect his knowledge. He can check if he understood the content of the lesson. For that, text, attachments (media packages), links, and graphics can be used.
- **Group Discussion:**
A group discussion is a dedicated forum a teacher/creator can add to a lesson to support discussions. The topics can be defined by the teacher/creator.
- **Study:**
Studies are text or media files to be consumed by students. It should not contain any tasks. A list is shown with PDF files, PPT files, Flash videos, JPGs, or any other document or file. If possible, these can be displayed in the web browser, if the consumer/student clicks on the "Show" icon.

Lessons with more than one learning path

The LiLa learner support system (formerly the tutoring system) gives teachers and students the possibility to build and follow lessons with an easy to use interface for lessons with more than one learning path. To achieve this the different learning activities are connected by the teacher. One activity can have one or more connections to other activities. That means that the

student can choose one of a number of different learning activities to do next. The system will give him a suggestion which way he or she should follow, but he or she is free in his choice to accept this suggestion or not. Branches in the learning path are situated at decision points. Hence they only make sense after assessments and sometimes after assignments.

There could be different scenarios how to check a result or solution of an assignment or assessment:

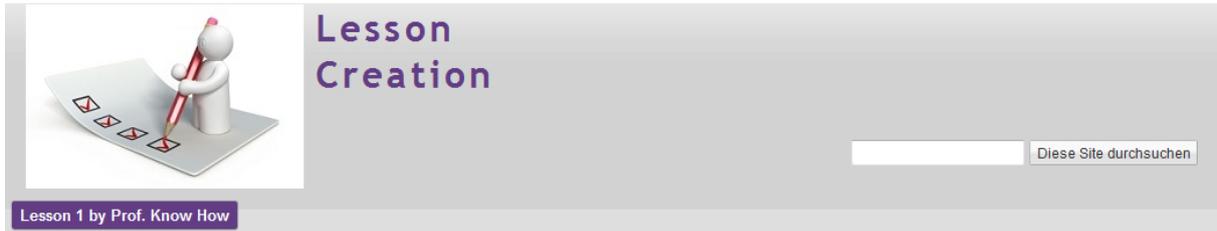
- The student compares his result with the result given by the teacher and decides himself, if his own result is correct or not. This is easy if the result is clear, like a solution of an equation. If the result is more complex, like a report on an experiment, e.g. a laboratory journal, that becomes more complicated for the student to decide if his or her result is good or not. In this case the next possibility to check a result could be useful:
- An expert checks the result of the student. The student gets in contact with the expert of the lesson and asks him to check his or her result (e.g. a report, document or laboratory journal). In this case he or she normally has to wait until the expert gives him feedback. If the student has more than one possibility to move on in the lesson after this assignment or assessment he or she could choose to wait until he or she gets a feedback of the expert or he or she can proceed with the next learning activity. Then he or she will ignore the suggestion of the system with which learning activity he or she should go on because he or she does not know yet if his or her result is good or bad. The lesson creator should take this possibility into account because that could cause a break in the lesson. We will provide good solutions for creating lessons with this kind of results (reports, documents, laboratory journals) in our teaching guidelines.
- In case the result of an exercise a number, equation or statement, testing the outcome of an exercise can also be left to the machine, i.e. an automatic test could be implemented.

3 An example on lesson creation

In the above section we provided only an overview on the lesson concept. In this chapter we describe the creation of a lesson as done by the teacher on an example, and show some mockups how we envision the system should look like. Please notice that the design of the mockup is not the final design of the LiLa portal. In the new deliverable of the Pedagogical Report (new D3.2) you will find the eventually design for the portal developed by an interface designer. For this report we only use a simple mockup to show and explain the functionalities of the LiLa learner support system.

The interface for lesson creation should be as easy and simple as possible. Teachers may already have designed good lessons or exercises for their lecture, for example. In this application, the lesson only need to be carried over to the LiLa portal, for example by copying and pasting the available texts, uploading additional material or inserting links into their lessons – reusing the existing material.

Figure 1 shows the introduction for the teacher how to prepare a lesson within the LiLa portal.


 A screenshot of the 'Lesson Creation' interface. On the left, there is a 3D illustration of a white figure holding a red pencil over a document with checkmarks. The title 'Lesson Creation' is displayed in purple. Below the illustration is a purple button labeled 'Lesson 1 by Prof. Know How'. On the right, there is a search bar with the text 'Diese Site durchsuchen' and a search icon.

Lesson 1 by Prof. Know How

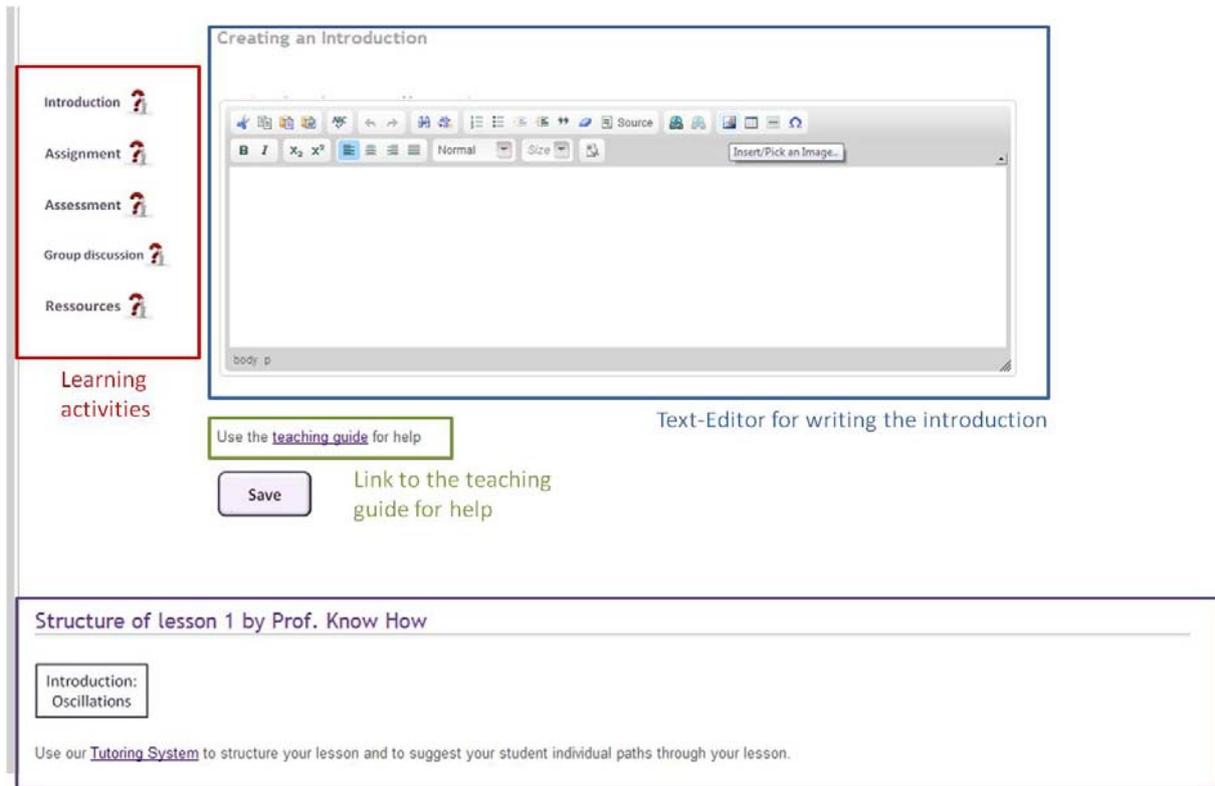
For creating a lesson you can find various learning activities on the left side. If you want more information on a learning activity use the Button behind the item of the learning activity.

- o Step 1: Choose a learning activity which you want to create. The related editor for creating and editing the learning activity will appear on the right side. If you need help please have a look at our [teaching guide](#).
- o Step 2: Write or create your learning activity. For help on that you can also use our [teaching guide](#) or visit the [Forum](#) to discuss with other lesson creators.
- o Step 3: Save your learning activity. You will see, that the learning activity now appears in the box at the end of this page "Structure of lesson..."
- o Step 4: Create another learning activity... if you want --> goto Step 1
- o Step 5: After creating all your learning activities you have three possibilities:
 - o you choose that your lesson will only be a collection of this learning activities without any further structure --> than you are done and can publish your lesson
 - o you want to structure your lesson --> than use the editor in the box at the end of this page, to arrange and connect your learning activities
 - o or you want to use our [Tutoring System](#) for building a lesson with some "decision points". Therefor you structure your learning activities as well and also put in some decision points where the student has to check his results and gets a suggestion how to move forward depending on this result. See [here](#) for an example.

figure 1: Introduction for lesson creation

This introduction also links to a teaching guide which is a help page to support lesson creation. Here teachers can find useful information and recommendations how to design and implement good lessons, assignments or assessments. They can also find examples for lessons or can get in touch with other lesson creators via the forum.

The first step for teachers is to choose a learning activity to become part of a lesson, where, typically, a teacher will start with an introduction on the subject. Figure 2 shows how the creation of an introduction could look like. On the left side (red box), the teacher can choose a learning activity. In this particular example, he has chosen "introduction". An introduction is a short description on the subject, usually by a text. Therefore a text editor is the main functionality of this page (blue box in figure 2). A teacher can also follow the link to the teaching guide to get hints and guidance on how to create a good introduction. At the bottom of the page - the purple box - the already saved learning activities within this lesson are shown. In figure 2, the introduction has already been saved and appears in this box, which is the editor for the structure of the lesson. In addition to learning activities, so called decision points – branches of the lesson – can be inserted here into the lecture as well. We will explain them in detail later in this section.

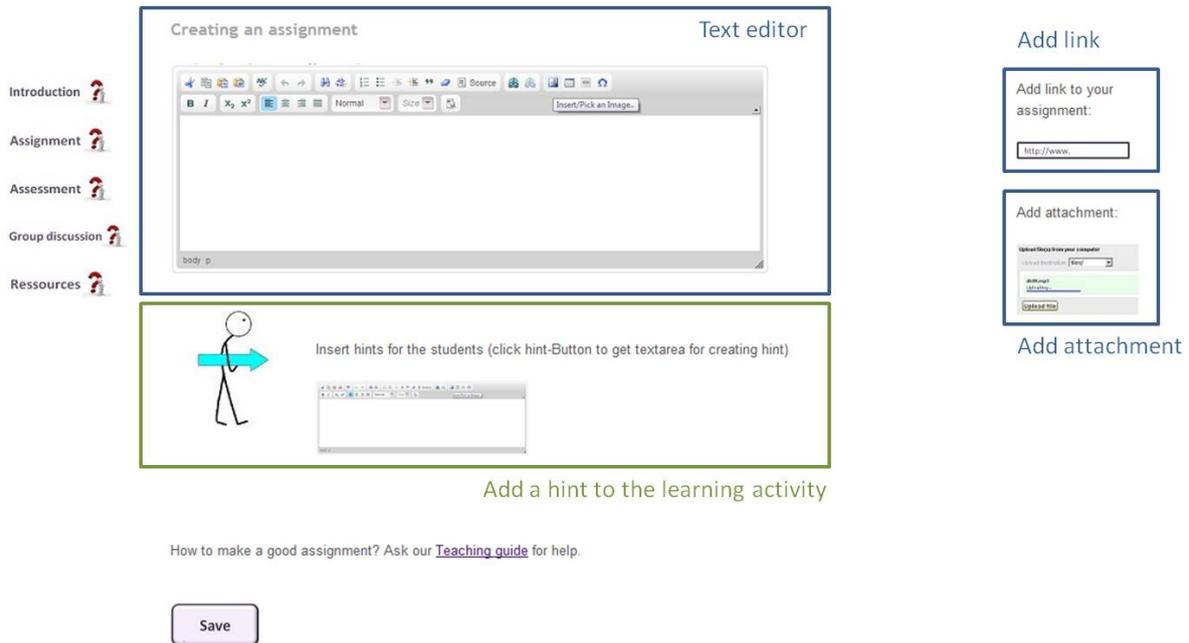


The screenshot shows a web-based interface for creating a tutoring system lesson. On the left, a sidebar contains a menu with five items: 'Introduction', 'Assignment', 'Assessment', 'Group discussion', and 'Ressources', each with a small icon. The 'Introduction' item is highlighted with a red box. Below the menu is a section titled 'Learning activities'. The main area is titled 'Creating an Introduction' and features a text editor with a toolbar containing various icons for text formatting and insertion. Below the text editor is a 'Save' button and a link that says 'Link to the teaching guide for help'. A green box highlights the text 'Use the teaching guide for help'. Below the main area, there is a section titled 'Structure of lesson 1 by Prof. Know How' with a sub-section 'Introduction: Oscillations'. At the bottom, a note reads: 'Use our Tutoring System to structure your lesson and to suggest your student individual paths through your lesson.'

Already saved learning activities – graphical editor for making a tutoring system lesson

figure 2: creating an introduction

The next step for the teacher is creating the next learning activity. He can choose between assignment, assessment, group discussion or resources. If he wants to create an assignment or an assessment, a text editor is provided as well. He can also upload an attachment or add a link to this learning activity, see figure 3 – blue boxes. In addition, links can be added to learning activities; these hints provide additional information for students that got stuck in solving or understanding the learning activity. A hint can be provided in the form of a text, an image, a small video or something similar. As an example, the mockup (figure 3) shows the possibility to provide an additional text as hint here. Despite hints, solutions for exercises can be uploaded, which are – obviously – invisible the first time the student is working through the lesson.



Creating an assignment Text editor

Introduction ?
 Assignment ?
 Assessment ?
 Group discussion ?
 Ressources ?

body p

Insert hints for the students (click hint-Button to get textarea for creating hint)

How to make a good assignment? Ask our [Teaching guide](#) for help.

Save

Add link

Add link to your assignment:

Add attachment:

Add attachment

Add a hint to the learning activity

Structure of Lesson 1 by Pro. Know How



figure 3: creating an assignment

The same functionalities are also provided for creating assessments.

After creating all learning activities, teachers need to structure the lesson. The simplest structure is a linear one, so the lesson will have only one learning path for all students. To get a more complex lesson with much more interactivity teachers could build a graph with various branches. This concept will be explained in detail in the next section.

4 A structured lesson with different learning paths

With the graphical editor a teacher can structure his lesson and define several paths through the lesson. In the following we will show, how to use the editor for setting up a lesson with various learning paths for the student.

Once a teacher has developed all his learning activities he has a collection of learning activities in the editor. For example his lesson contains an introduction, two assignments and three assessments (figure 4). As already mentioned, the simplest way will be to connect these learning activities in a linear way (figure 5).

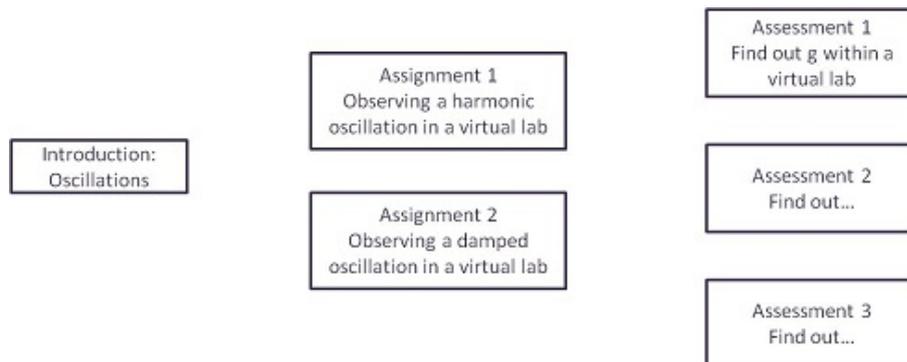


figure 4: collection of learning activities

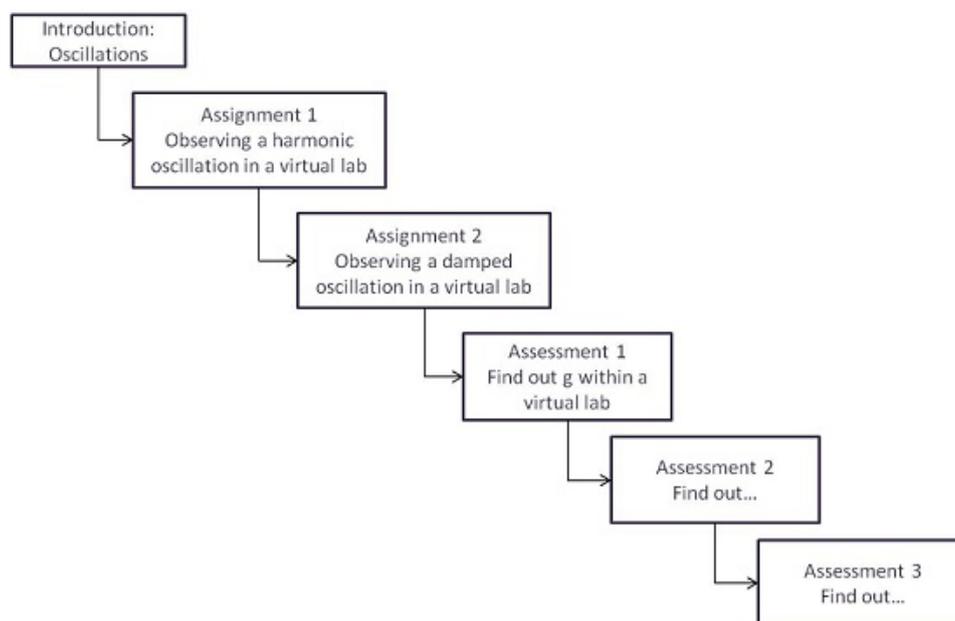


figure 5: linear lesson

In the case the teacher wants to follow our suggestion, namely to design a more complex lesson to be more learner centered, the teacher could build a graph like structure as shown in figure 6. This graph is a simple example for a lesson with more than one learning path. In this structure students which solved the task in assessment 1 with a special result, e.g. a correct calculation, should follow path 1 whereas students providing the wrong outcome should follow the second path.

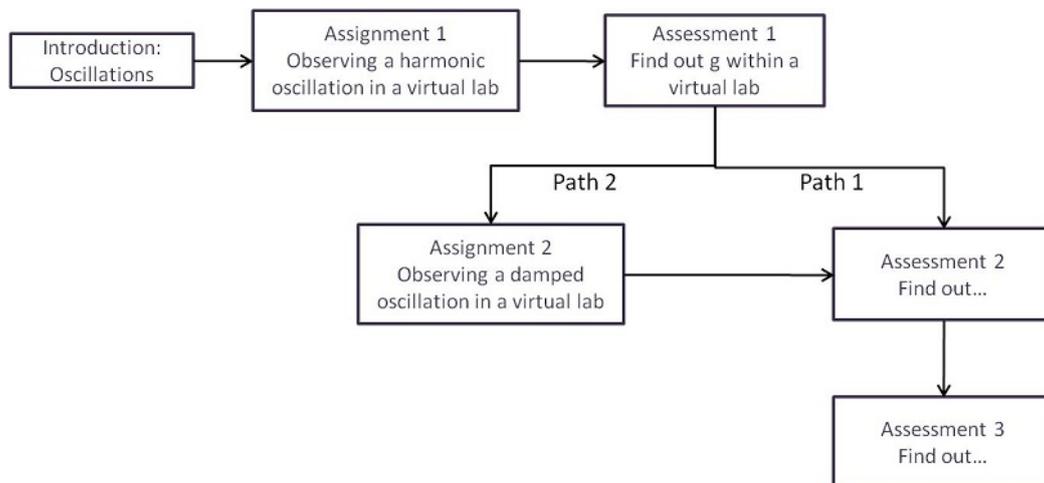


figure 6: different learning paths through the lesson

Here a more detailed example (figure 7):

Imagine the student's task is to do a self assessment in a Learning Management System. His or her result is 49 points out of 100. For this result the suggestion of the system is "continue with the assignment Superposition of waves" (red arrow in figure 7).

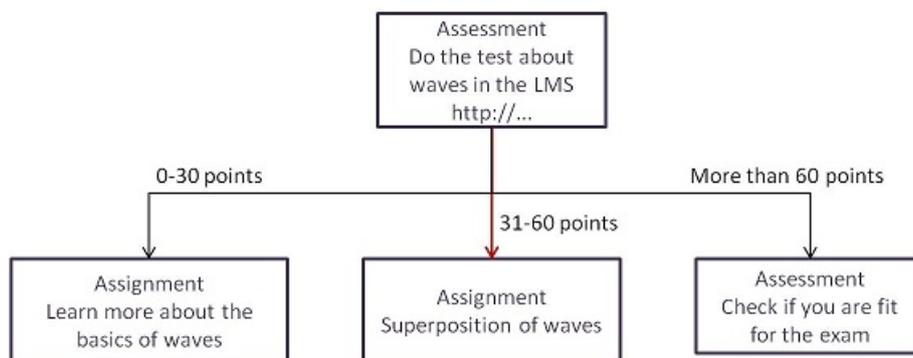


figure 7: checking a result of an assessment and choose a next activity

This kind of functionality exists only after assessments and some kind of assignments because these are learning activities which produce results.

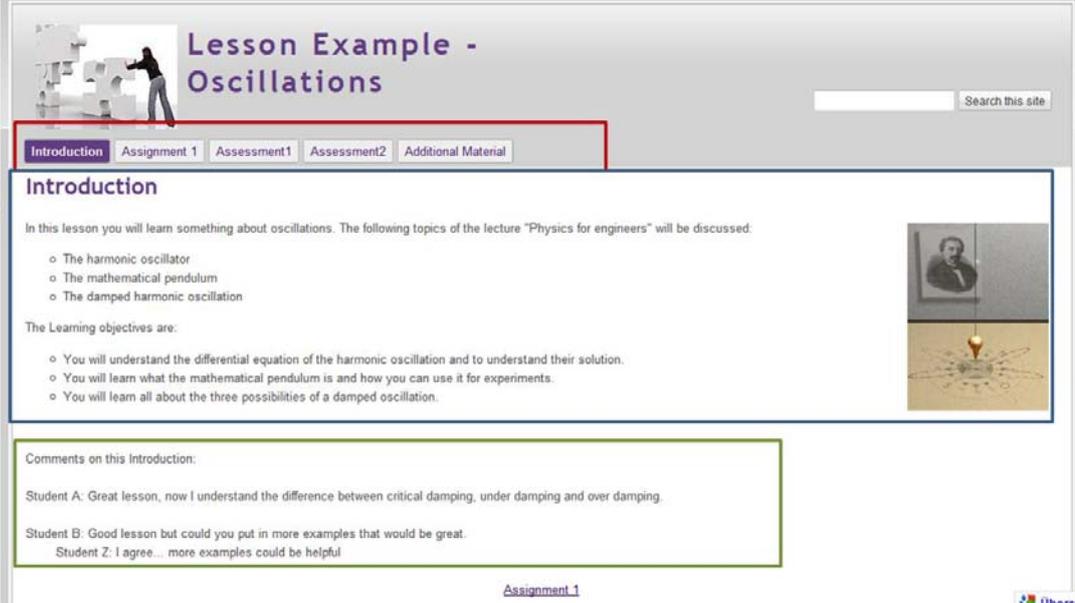
5 A lesson – execution

Switching from the teacher view to the student view, we now present some insight into how students observe learning activities in the LiLa portal: Students can search for experiments and material on topics of interest, or students could perform experiments as assigned by a teacher; despite performing simple learning activities, students are of course encouraged to follow entire lessons – prepared by teachers as shown in the previous section.

As already mentioned in the above section, the simplest lesson is a linear lesson. Our example shows a fictitious lesson on oscillations. The red box in figure 8 marks the navigation bar. In case of a linear lesson navigation is really simple. The student can choose between the

different learning activities like the introduction, the assignment, the assessment or additional material. Each page links to the next learning activity.

The blue box in figure 9 shows the content of the introduction. In the section 3 “An example on lesson creation” in this report we have already illustrated how a teacher will set up all this content for a lesson. A student can make comments on the introduction (see green box in figure 9). Hence, students are able to provide feedback or short advices for the teacher, for other teachers or other students – in short for all other users.



Navigation through the lesson

Introduction of the lesson

Comments of some students

Lesson Example - Oscillations

Search this site

Introduction Assignment 1 Assessment1 Assessment2 Additional Material

Introduction

In this lesson you will learn something about oscillations. The following topics of the lecture "Physics for engineers" will be discussed:

- The harmonic oscillator
- The mathematical pendulum
- The damped harmonic oscillation

The Learning objectives are:

- You will understand the differential equation of the harmonic oscillation and to understand their solution.
- You will learn what the mathematical pendulum is and how you can use it for experiments.
- You will learn all about the three possibilities of a damped oscillation.

Comments on this Introduction:

Student A: Great lesson, now I understand the difference between critical damping, under damping and over damping.

Student B: Good lesson but could you put in more examples that would be great.

Student Z: I agree... more examples could be helpful

Assignment 1

iThare

figure 8: Introduction to the lesson example

The assignment is just another element type of a lesson. An assignment could explain facts, it can use also experiments and it provides students with a description to perform a task in the system, let it be alone or along with others. That is, assignments are, unlike introductions, interactive elements. Figure 9 and 10 show a first assignment in our lesson example. The harmonic oscillator is the topic of this assignment (figure 9). It consists of an experiment and a task to solve with this experiment (figure 10).

There are various possibilities for creating assignments – and we support teachers in creating pedagogical sound assignments by a teaching guide as we do for introductions. If the assignments asks the student to provide an answer – for example to calculate something or to write a lab report on an experiment or to collect measuring data etc. – the student could check his result by asking an expert or by looking at the sample solution given by the teacher.

In the assignment the student also some other possibilities (green box in figure 10):

- The student can get a hint. A hint is additional short information for the student. If he has some problems in understanding the task or the content of the assignment he can click on the hint and then additional information pops up. Hints can be created by the teacher but also by other students.
- The student can visit the forum and get in contact with other users who do the same assignment or a similar topic and want to discuss the content.

- The student can leave a comment.

Introduction **Assignment 1** Assessment 1 Assessment2 Additional Material

Assignment 1

First assignment of the lesson

The harmonic oscillator

In classical mechanics, a **harmonic oscillator** is a system which, when displaced from its equilibrium position, experiences a restoring force, F , proportional to the displacement, x according to Hooke's law:

$$F = -kx$$

where k is a positive constant.

If F is the only force acting on the system, the system is called a **simple harmonic oscillator**, and it undergoes simple harmonic motion: sinusoidal oscillations about the equilibrium point, with a constant amplitude and a constant frequency (which does not depend on the amplitude).

If a frictional force (damping) proportional to the velocity is also present, the harmonic oscillator is described as a **damped oscillator**. Depending on the friction coefficient, the system can:

- Oscillate with a frequency smaller than in the non-damped case, and an amplitude decreasing with time (**underdamped oscillator**).
- Decay exponentially to the equilibrium position, without oscillations (**overdamped oscillator**).

If an external time dependent force is present, the harmonic oscillator is described as a **driven oscillator**.

Mechanical examples include pendula (with small angles of displacement), masses connected to springs, and acoustical systems. Other analogous systems include electrical harmonic oscillators such as RLC circuits. The harmonic oscillator model is very important in physics, because any mass subject to a force in stable equilibrium acts as a harmonic oscillator for small vibrations. Harmonic oscillators occur widely in nature and are exploited in many manmade devices, such as clocks and radio circuits. They are the source of virtually all sinusoidal vibrations and waves.

For understanding the basics of a harmonic oscillator we will use an experiment.

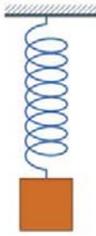
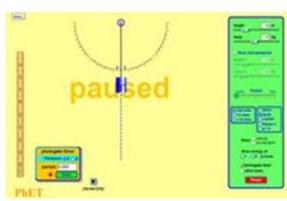


figure 9: First assignment in the lesson example – theoretical background

Integrated Experiment and task to solve

For understanding the basics of a harmonic oscillator we will use an experiment.



Simulation "[Pendulum lab](#)"

Start the PhET Pendulum Experiment.

1. Use $L = 1$ m as length
2. Use a 5 degree angle for your measurements
3. Activate the photogate timer
4. Please check that you choose "friction none" for this task

Measure the time the pendulum needs for one oscillation.

Question: Which value do you get for acceleration of gravity g ?

Hint, Comments, Discussion (Forum)

 Need a hint?
 Leave a comment
 Discuss the topic in the forum

figure 10: First assignment in the lesson example – experiment and task to solve

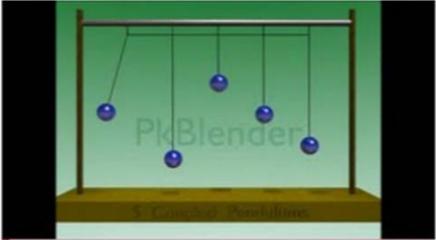
Assessments are the third type of learning activity available in the portal. It implements a test or self-assessment for students; figure 11 shows an example of an assessment: Amongst a text that describes the task to solve, it may also contain an experiment. The possibilities for the student to get help on the assessment are (green box in figure 11):

- Leave a comment
- Discuss in the Forum
- Ask an expert for help or for correcting the own solution/result of the assessment.

Assessment - Task

Coupled Pendulum

Here you see a coupled pendulum. What will happen when you deflect the first ball on the left side and let it oscillate?



Explain what will happen and also explain why this will happen. Use the LiLa Portal to find an experiment in which you can prove your explanation.

 Leave a comment

 Forum discussion

 Ask an expert

Comments, Discussion (Forum), get in touch with an expert

figure 11: Assessment in the lesson example

The sole purpose of an assessment is, of course, to estimate the learning success, and – for the student – to collect feedback on the answers given. This is the interesting part for the new learner support system because we offer various possibilities to check or discuss results: The student can ask an expert for checking his result, where an expert is someone who is familiar with the topic of the lesson and mentions himself an expert, e.g. the assistant of the lecturer or the lecturer/teacher himself. The student could discuss questions on the assessment, problems and also his results in a forum, all of which are social learning tools already mentioned in the tutoring system report (Deliverable 3.1) before. If the lesson is build in a way that it has more than one possible learning path, the system suggests the student the next learning activity depending on the outcome of this assignment/assessment. Figure 12 shows an example for two different learning paths. While only being a simple example, it should be sufficient to demonstrate the idea of our learning support system.

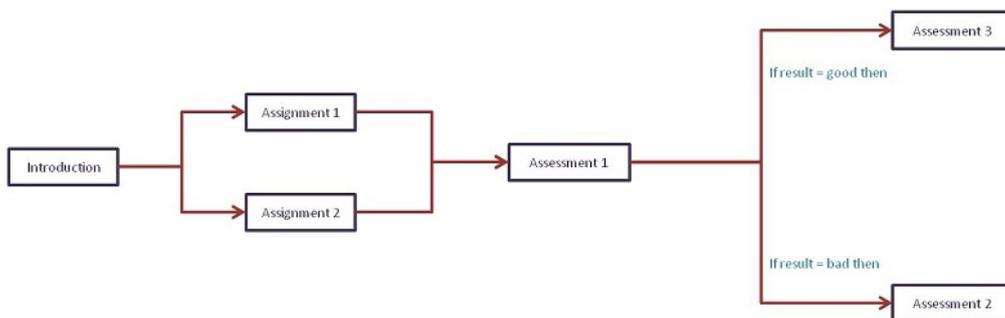


figure 12: example for different learning paths



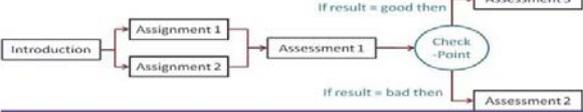
Imagine the student is now doing assessment #1 and provides a solution; following that, the LiLa system offers several possibilities to check the validity of the result:

- The student could compare his result with the solution given by the teacher. This part is not integrated in the mockup of the lesson page because that will be only a link to the solution that remains hidden until the student provides a result.
- A student could ask the expert to check his result of the assessment, but then has to wait for feedback. He could follow the suggestion of the teacher “do assessment 3 if your result is correct/good” or he could do assessment 2 as well if he does not want to follow the suggestion. It is here, once again, important that the system does not try to “patronize” its users, but only provides suggestions.
- Students can discuss results in the forum and get there the information whether the provided answer is reasonable. Again, the outcome of a discussion on the forum should help the student to decide on how to continue with the lesson and which learning activity to select next.
- Another possibility is that the system (the portal) can check the validity of the answer; this is applicable whenever simple, easily machine-checkable questions are given, and the course designer – the teacher – provided the correct solution. In this case, an automated system provides a suggestion for the next learning activity right away. Again, students may or may not follow such suggestions.

In the case of a lesson with more than one learning path the navigation bar will look different for the user – figure 13 shows an example. It is obvious that the learning path with all learning activities will always be transparent for the student, also in the case that the system checks his answer of an assessment. We still have to think on the layout of the navigation because a complex lesson may create a confusingly complex navigation bar; nevertheless, the main idea is still to offer the same navigation functionalities for students and for teachers.

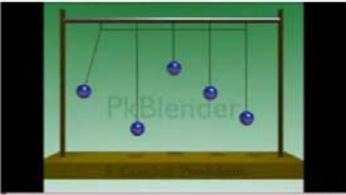


Lesson Example - Oscillations



Coupled Pendulum

Here you see a coupled pendulum. What will happen when you deflect the first ball on the left side and let it oscillate?





You want to discuss this task with others?
Use the forum for discussion on this topic.



You want to ask an expert or send your solution to the expert? Then click on the "Ask the expert"-Image.

Explain what will happen and also explain why this will happen. Use the LiLa Portal to find an experiment in which you can prove your explanation.

If you need a hint, click here



Navigation bar

figure 13: lesson with more than one learning path - navigation bar

6 Next steps of the tutoring system

The next steps by integrating the new LiLa learner support system into the portal are:

- Implementation of the lesson creation for the teacher within the portal in the design of the LiLa portal
- Integration of the graphical editor of the learner support system which already exists as a standalone application and has to be adapted and integrated into the lesson creation of the LiLa portal
- Implementation of the lesson view for the students/users in the design of the LiLa portal
- Integration of the graphical interface of a lesson as navigation bar for the student
- Testing the lesson creation by creating first lessons in the LiLa portal. The content of these lessons already exists and has only to be transferred into the lesson of the portal.
- Testing these created lessons by a group of students and collect feedback from the testing group.
- Adapt the lesson concept in the portal due to the feedback of the student group