Deliverable 3.1

PBL modules analysis and configuration

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Editor(s): Wilfrid Utz (BOC)
Responsible Organisation: BOC
Version-Status: V1 Final
Submission date: 30/06/2017
Dissemination level: PU
Deliverable factsheet

<table>
<thead>
<tr>
<th>Project Number:</th>
<th>562236-EPP-1-2015-1-EL-EPPKA3-PI-FORWARD</th>
</tr>
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<tr>
<td>Project Acronym:</td>
<td>PBL3.0</td>
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<tr>
<td>Project Title:</td>
<td>Integrating Learning Analytics and Semantics in Problem Based Learning</td>
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<th>Title of Deliverable:</th>
<th>D3.1 – PBL modules analysis and configuration</th>
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<tr>
<td>Work package:</td>
<td>WP3 – PBL_LA modules configuration</td>
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<tr>
<td>Due date according to contract:</td>
<td>30/06/2017</td>
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<tr>
<th>Editor(s):</th>
<th>Wilfrid Utz (BOC)</th>
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<td>Contributor(s):</td>
<td>All Partners</td>
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<td>Reviewer(s):</td>
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<td>Approved by:</td>
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Abstract:

This report documents the identification and configuration of the PBL modules/tools and the Learning Analytics modules/tools, which will collect and analyze data to produce valuable information. Thus, one of the main tasks of the report is the identification of existing modules/tools that could be reused and the selection of the most appropriate to be deployed. Furthermore, a model-based approach for the design and an e-learning platform for the execution of selected courses are analyzed and configured.

Keyword List:

Problem-Based Learning, Learning Analytics, course design, course execution, course assessment, ECAAD, MOODLE,
| Modelling |  |
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<th>Revised by</th>
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<td>V01</td>
<td>24/03/2017</td>
<td>BOC</td>
<td>Provision of starting version to the partners</td>
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<tr>
<td>V02</td>
<td>15/05/2017</td>
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<td>Contributions added</td>
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<tr>
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Statement of originality:
This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Disclaimer:
This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.
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# List of Abbreviations

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<tr>
<td>ADL</td>
<td>ADOxx Definition Language</td>
</tr>
<tr>
<td>AQL</td>
<td>ADOxx Query Language</td>
</tr>
<tr>
<td>ATTLS</td>
<td>Attitudes to Thinking and Learning Survey</td>
</tr>
<tr>
<td>COLLES</td>
<td>Constructivist On-Line Learning Environment Survey</td>
</tr>
<tr>
<td>CoP</td>
<td>Community of Practice</td>
</tr>
<tr>
<td>CSV</td>
<td>Comma-Separated Values</td>
</tr>
<tr>
<td>DTD</td>
<td>Document Type Definition</td>
</tr>
<tr>
<td>ECAAD</td>
<td>Evidence Centred Activity and Assessment Design</td>
</tr>
<tr>
<td>ECD</td>
<td>Evidence Centred Design</td>
</tr>
<tr>
<td>HTML</td>
<td>Hypertext Markup Language</td>
</tr>
<tr>
<td>HTTP</td>
<td>Hypertext Transfer Protocol</td>
</tr>
<tr>
<td>ISAD</td>
<td>Information Systems Analysis and Design</td>
</tr>
<tr>
<td>JSON</td>
<td>JavaScript Object Notation</td>
</tr>
<tr>
<td>LA</td>
<td>Learning Analytics</td>
</tr>
<tr>
<td>LMS</td>
<td>Learning Management System</td>
</tr>
<tr>
<td>LS</td>
<td>Learning Semantics</td>
</tr>
<tr>
<td>Moodle</td>
<td>Modular Object-Oriented Dynamic Learning Environment</td>
</tr>
<tr>
<td>MySQL</td>
<td>My Structured Query Language</td>
</tr>
<tr>
<td>ODS</td>
<td>OpenDocument Spreadsheet</td>
</tr>
<tr>
<td>OMiLAB</td>
<td>Open Models Initiative Laboratory</td>
</tr>
<tr>
<td>PBL</td>
<td>Problem Based Learning</td>
</tr>
<tr>
<td>PBL_LA</td>
<td>Problem Based Learning &amp; Learning Analytics</td>
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<tr>
<td>PDCA</td>
<td>Plan-Do-Check-Act</td>
</tr>
<tr>
<td>PHP</td>
<td>PHP: Hypertext Preprocessor</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
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<tr>
<td>WP</td>
<td>Work Package</td>
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<tr>
<td>XML</td>
<td>eXtensible Markup Language</td>
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Executive Summary

The overall aim is to enhance Problem Based Learning (PBL) with Learning Analytics (LA) and Learning Semantics (LS). Therefore we follow a new educational paradigm and pilot it to produce relevant policy recommendations.

We aim to identify, configure and adapt Learning analytics tools or modules and PBL tools to meet the needs of the PBL_LA approach. For this reason two main categories of tools are identified and configured: i) PBL modules and tools that will collect data that derive directly from the PBL educational approach and ii) Learning analytics and tools that analyse the collected data to produce valuable information. Furthermore the model-based approach and tool (ECAAD) is analysed and configured. Accordingly, the selected and configured tools will be deployed into the Community of Practice (CoP) platform, which is based on an existing LMS environment namely Moodle. Overall, we target the following objectives:

- To identify and analyze existing Learning Analytics tools
- To deploy the appropriate Learning Analytics tools for the needs of PBL_LA educational approach
- To install the CoP platform and integrate the configured tools into the e-learning space.
- To integrate and configure the model-based approach on continuous learning and skills assessment

The present document reports the deployment and configuration of modules and tools that will collect data that derive directly from the PBL educational approach. Thus, in the first step existing modules and tools, which could be reused, will be identified and the most suitable tools, to be deployed, will be selected. To achieve the set objectives an architecture based on the three phases of learning (design, execution, evaluation) has been established. For testing purposes 3 Use cases namely the ADOxx.org training (BOC), a project on Audio-Visual Experiments provided at the University of Aalborg and the project part of the Information Systems Analysis and Design course provided at the University of Macedonia, were determined. The ADOxx.org training is a technical use case, which aims to test the model based approach and the functionality of the modules and tools within the Platform (Moodle). The two other use cases are pedagogical and based on the PBL educational approach.
1 Introduction

1.1 Scope

The deliverable 3.1 (D.3.1) “PBL modules analysis and configuration” targets to describe all the work carried out to analyze and configure the model-based approach and tool (ECAAD) used for the design phase. In addition, it aims to describe all the work carried out to deploy and configure PBL modules and tools that collect data during the execution phase and Learning analytics tools, which generate useful information out of the collected data.

1.2 Audience

The intended audience for this document is the PBL3.0 consortium, the European Commission, and the public interested in tools and modules for gathering and analysing of data that derive from the PBL educational approach as well as the model-based approach and tool for the design environment.

1.3 Structure

The structure of the document is as follows:

- Section 2 deals with the High-Level Architecture followed in this deliverable.
- Section 3 presents a description of some selected generic learning analytics tools for the Learning Management System Moodle.
- Section 4 examines the platforms and tools used for the particular environment. Further it provides a comparison of the learning design (ECAAD) and the learning execution (Moodle) based on one chosen use case. In addition, the last subchapter present a selection of Moodle tools for the PBL approach.
- Section 5 is split into two parts. The first part deals with the deployment within the environments and the second part gives a picture on how the three use cases were modelled in ECAAD.
- Section 6 concludes the document.
2 High-Level Architecture

Figure 1: High-level Architecture

Figure 1 depicts the High-level Architecture consisting of three environments. The approach is based on the PDCA (Plan-Do-Check-Act) cycle. The PDCA cycle is an approach, which aims to ensure the permanent improvement of processes.¹

The planning of a course happens in the Design Environment. In the first step, in order to provide an appropriate and well structured modelling method, a Meta model has to be defined.

---

The deployment of the ECAAD Meta Model is conducted on the ADOxx Meta Modelling Platform. The result of the deployment is the ECAAD Designer tool, which then can be used to model courses. Further, for the purpose of data storage the models of the course will be deposited in a repository. The models then can be exported in different formats to be used as a package, which will contain information and data about the particular courses.

For the execution as well as the evaluation of the three use cases the Learning Management System (LMS) Moodle will be used. During the execution of a course data is generated and gathered by the use of the Moodle plugins. These data, which is mainly produced by the course participants, is stored in a course repository and can be used for the evaluation.

To process the data issued during the execution in order to get valuable information the Moodle Learning Analytics plugins can be used. Moreover, in order to visualize the information in a structured way some analytics tools provide a dashboard. An example of an open source Moodle integrable analytics tool, which provides a well structured dashboard and thus can be used to support the evaluation, is described in section 3.13.

After the evaluation the results are interpreted and based on that the models in the design phase will be changed if necessary.
3  List of open source Tools for Moodle

3.1  Logs\(^2\)

With the use of Logs, which are built in and do not have to be installed, reports on course activity or site activity can be viewed. Figure 2 shows the options, which can be logged as well as the results. The first selection field gives the possibility to choose the whole site or a particular course in Moodle. In the second field, a single participant or all users can be selected to be logged. The next fields regard the day, the activities, the actions, the sources used and the events. The result table shows the exact time when the actions were taken, the user name, the context in which user and component were affected, the name of the event, a detailed description as well as the origin and IP address. Thus, logs are especially useful for checking the participation and action of users in Moodle. In addition, the results can be downloaded in a .csv, .xlsx, .html, .json or .ods format.

Furthermore, there is even a tool to track activities within the last hour. For this purpose the live logs report can be used. It shows all events, which occurred during a period of time within a course and regards all users. Figure 2 depicts logs concerning all activities of a specified user within the ADOxx.org Training and Figure 3 shows all live logs of the ADOxx.org Training, which are updated every sixty seconds.

\(^2\) Cf. https://docs.moodle.org\(^a\).
<table>
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<th>Time</th>
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<th>Affected user</th>
<th>Event context</th>
<th>Component</th>
<th>Event name</th>
<th>Description</th>
<th>IP address</th>
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<td>ADOxx.org Training Administrator</td>
<td>-</td>
<td>Forum: Announcements</td>
<td>Forum</td>
<td>Course module viewed</td>
<td>The user with id '2' viewed the 'forum' activity with course module id '33'.</td>
<td>web</td>
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<tr>
<td>18 Apr</td>
<td>ADOxx.org Training Administrator</td>
<td>-</td>
<td>Forum: Announcements</td>
<td>Forum</td>
<td>Discussion created</td>
<td>The user with id '2' has created the discussion with id '2' in the forum with course module id '33'.</td>
<td>web</td>
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<tr>
<td>18 Apr</td>
<td>ADOxx.org Training Administrator</td>
<td>-</td>
<td>Forum: Announcements</td>
<td>Forum</td>
<td>Some content has been posted</td>
<td>The user with id '2' has posted content in the forum post with id '2' located in the forum with course module id '33'.</td>
<td>web</td>
</tr>
<tr>
<td>18 Apr</td>
<td>ADOxx.org Training Administrator</td>
<td>-</td>
<td>Forum: Announcements</td>
<td>Forum</td>
<td>Course module viewed</td>
<td>The user with id '2' viewed the 'forum' activity with course module id '33'.</td>
<td>web</td>
</tr>
</tbody>
</table>

**Figure 2: ADOxx.org Training logs report**
The activity report gives an overview of the views of each activity in each section of a course in Moodle. Hence, this tool is appropriate to check the number of visitors for each added activity without focusing on particular users. In this way, teachers can control whether their students visit the course on Moodle or whether they have to take action to encourage the students. Furthermore, the time span, which the report should cover, is determined by the log lifetime which is set

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separately in Moodle. In addition, if activity reports for courses are activated, each user can view her own activity report.

Moreover, if a teacher wants to assess the participation of her students she can use the course participation report. For this report the activity module, the time span to look back and the actions to be shown can be selected. The results can show the activities of a guest or a student depending on what has been selected. For example if a student has viewed a selected activity module, then the result table depicts a “YES” under the View column. In this case, the amount of views is displayed in parenthesis beside the answer. Furthermore, the teacher has the possibility to select the displayed users and send a message to them. In this way the teacher can remind the students to view an important document in case the answer to the view request was “NO”. Figure 4 shows the result table of an ADOxx.org Training activity report and Figure 5 depicts a course participation report request for the ADOxx.org Training.

ADOxx.org Training

Computed from logs since Tuesday, 11 April 2017, 9:32 AM.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Views</th>
<th>Related blog entries</th>
<th>Last access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agenda</td>
<td>3 by 1 users</td>
<td>-</td>
<td>Thursday, 13 April 2017, 11:14 PM (4 days 22 hours)</td>
</tr>
<tr>
<td>Connect to Eduroam</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Create new database</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Welcome (Training Plan)</td>
<td>1 by 1 users</td>
<td>-</td>
<td>Thursday, 13 April 2017, 18:44 AM (5 days)</td>
</tr>
</tbody>
</table>

OMILAB Introduction

<table>
<thead>
<tr>
<th>Activity</th>
<th>Views</th>
<th>Related blog entries</th>
<th>Last access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intro OMILAB</td>
<td>1 by 1 users</td>
<td>-</td>
<td>Thursday, 13 April 2017, 11:41 AM (4 days 21 hours)</td>
</tr>
</tbody>
</table>

Introduction to ADOxx

<table>
<thead>
<tr>
<th>Activity</th>
<th>Views</th>
<th>Related blog entries</th>
<th>Last access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to ADOxx (Training Plan)</td>
<td>3 by 1 users</td>
<td>-</td>
<td>Thursday, 13 April 2017, 2:07 PM (4 days 21 hours)</td>
</tr>
<tr>
<td>Introduction to ADOxx</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hello World</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: ADOxx.org Training activity report
3.3 Activity completion

The Activity completion tool can be used either as a progress list for the course or as a checklist for the students. Hence, there are two options for completion tracking: the teacher can allow the students to mark the completed activity manually or let the checking be done automatically if predefined conditions are met. To be able to access the Activity completion in the course reports, the activity completion option has to be enabled for at least one activity within a course. The Activity completion report (Figure 6) shows the users enrolled to the particular course, the activities for which the completion option is activated, the deadline for the completion and whether the users have completed the activities or not. In addition, the report can be downloaded in a .csv format.

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4 Cf. https://docs.moodle.org\[d\].
3.4 Survey

A survey is one of Moodles activity modules. It uses predefined survey types with prepared questions. The two main survey types are COLLES (Constructivist On-Line Learning Environment Survey) and ATTLS (Attitudes to Thinking and Learning Survey). Using the COLLES survey type the teachers can gather information from their students regarding six main points of the online course. These points are relevance, reflective thinking, interactivity, tutor support, peer support and interpretation. Furthermore, the teachers have the possibility to view reports on the results of the surveys. For the COLLES survey type, they can view a summary chart of the responses on the six main points. In contrast, the ATTLS survey type offers a summary chart with two main points namely connected learning or separated learning. A report on all questions and the distribution of the answers is available for both survey types, as well as a list of all users that participated in the survey. Figure 7 depicts an extract of a COLLES survey and Figure 8 shows the corresponding summary chart.

---

Survey

The purpose of this survey is to help us understand how well the online delivery of this unit enabled you to learn. Each one of the 24 statements below asks about your experience in this unit. There are no 'right' or 'wrong' answers; we are interested only in your opinion. Please be assured that your responses will be treated with a high degree of confidentiality, and will not affect your assessment. Your carefully considered responses will help us improve the way this unit is presented online in the future. Thanks very much.

All questions are required and must be answered.

### Relevance

<table>
<thead>
<tr>
<th>Responses</th>
<th>Not yet answered</th>
<th>Almost never</th>
<th>Seldom</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My learning focuses on issues that interest me.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. What I learn is important for my professional practice.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. I learn how to improve my professional practice.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. What I learn connects well with my professional practice.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Reflective thinking

<table>
<thead>
<tr>
<th>Responses</th>
<th>Not yet answered</th>
<th>Almost never</th>
<th>Seldom</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. I think critically about how I learn.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6. I think critically about my own ideas.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7. I think critically about other students' ideas.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8. I think critically about ideas in the readings.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Interactivity

<table>
<thead>
<tr>
<th>Responses</th>
<th>Not yet answered</th>
<th>Almost never</th>
<th>Seldom</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. I explain my ideas to other students.</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 7: COLLES survey
3.5 Course overview report

The course overview report is useful if a comparison of all courses in Moodle is needed. Hence, the report is only available for users with site administration rights. Through the provided reports the user can for example view bar charts or tables of courses with the highest participation or activity. Thereby the activity is being calculated by the number of posts (submissions and responses) plus the number of views of resources or activities, and the participation is the division of posts by views in a course. Figure 9 depicts an example of a chart for the most active courses.

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3.6 Course completion status

The course completion status block gives students the opportunity to see the criteria, which they need to fulfil in order to complete the course. Furthermore, when they fulfil one of the required criteria it is immediately shown in the status block. In addition, if the students want to get further information about the activities to be completed or the requirements set, they can either view the “More details” or “View course report” option. The “More details” option shows among others the criteria, the requirements for each criterion and whether they have been completed. The course report shows a checklist for every user with all the given criteria. The course completion status block is depicted in Figure 10. Furthermore, Figure 11 depicts the course completion progress details and Figure 12 shows the course completion report.

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7 https://docs.moodle.org; https://docs.moodle.org.
D3.1 PBL modules analysis and configuration

Figure 10: Course completion status block

Figure 11: Course completion progress details
3.7 Progress bar

Contrary to the tools before, the progress bar is not included in Moodle and needs to be downloaded and installed. After the installation the progress bar can be added as a block to the course. In a first step the teacher can select particular activities or resources which have to be completed, or add all of them at once. The students then will see a progress bar block, which shows them what activities need to be completed or resources viewed in order to meet the requirements set by the teacher. Furthermore, after every finished task a check will appear in the task box and the percentage achieved will also be shown. Moreover, the deadline for the particular task is also depicted on the progress bar block. In addition, the teachers have the possibility to get an overview of the progress bars of all students in a course. Figure 13 depicts a progress bar block from a student’s point of view and Figure 14 shows an overview of students’ progress bars accessed by a teacher.

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3.8 Events list\textsuperscript{10}

Using the events list report tool, teachers can view all events, which affected components regarding the two main education levels, “teaching” and “participating”. If the teaching educational level is selected, then the report shows all events that concern the learning experience. This could be for example the posting of grades for a course section. By contrast, “participating” concerns the learning experience from the students point of view, for example in case they post something to a forum. Figure 15 shows a report request for the advanced mind map component on the “participating” educational level.

\textsuperscript{10} Cf. https://docs.moodle.org.
3.9 Activity results block

The activity results block can be used to inform the students about the overall results of graded activities. Before any results are displayed the teacher has to configure the block in the settings. The settings include the particular activity to display the results of, the number of the highest grades, the number of the lowest grades, and the option whether to show student’s or group’s scores. In addition, one very important option concerns the privacy of results. Here the three options are to either display full names, to display only ID numbers, or to display anonymous results. If the teachers want to display full names, they first should check if it is not against the law and then ask their students if they agree. Furthermore, the results can be displayed in percentages, fractions or absolute numbers. Figure 16 shows the settings for the activity results block and Figure 17 depicts an example of results displayed in the block.

---

Configuring a Activity results block

- **Block settings**
  - Which activity should this block display results from? 
    - Quiz1
  - How many of the highest grades should be shown (0 to disable)?
    - 2
  - How many of the lowest grades should be shown (0 to disable)?
    - 1
  - Show groups instead of students (only if the activity supports groups)?
    - Yes
  - Privacy of results
    - Display full names
  - Display grades as
    - Percentages
  - Decimal places to display
    - 2

- **Where this block appears**

- **On this page**

  ![Activity results block settings](image)

**Figure 16: Activity results block settings**
3.10 Configurable reports

The configurable reports plugin allows the users to compose their own reports. For this purpose, five different types of reports can be created. These five types are: categories report, courses report, users report, timeline report and SQL report. To export the created report three formats are available, namely: .csv, .ods and .xls. The options to customize the report can differ depending on the selected type of the report. Furthermore, for the SQL reports a list of ad-hoc contributed reports written in SQL, and available on the Moodle webpage, can be very useful. Figure 18 depicts how such a custom report might look like.

Figure 17: Activity results block results example

![Figure 17](image)

Figure 18: Example of a custom report

![Figure 18](image)

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12 https://docs.moodle.org
13 Cf. https://moodle.org
14 Cf. https://docs.moodle.org
15 https://moodle.org
3.11 Ad-hoc database queries\textsuperscript{16}

With the Ad-hoc database queries plugin administrators can create queries, which then can be made available for other users. On the first page of the plugin the administrators have two options. They can either directly create a new query by “Add a new query”, or create a new category for the query first, by clicking on “Manage report categories”. To add a new query a query name and the query written in SQL are required. Thus, the creator of such a database query must have knowledge about SQL and also about the corresponding database structure in Moodle. The SQL statements and the result of a query, which show the total number of enrolled users independent of their roles for all available courses, are depicted in Figure 19 respectively Figure 20.

\textbf{Figure 19: Ad-hoc database query SQL statement example}

\textsuperscript{16} Cf. http://moodle.org\textsuperscript{Q}; https://docs.moodle.org\textsuperscript{F}. 
3.12 Course dedication\textsuperscript{17}

The course dedication plugin gives teachers the possibility to observe the time, which students dedicate for a particular course. The required data to be selected in order to get the results is the start of the period and the end of the period, which should be taken into account. In addition, the teacher has to select a limit between clicks (in minutes). The results display the elapsed time between the start and the end period, the total dedication time of all users, a mean dedication time and a table with the dedication values for all enrolled users. An example of such a course dedication request is shown in Figure 21.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig20.png}
\caption{Ad-hoc database query result}
\end{figure}

\textsuperscript{17} Cf. https://moodle.org\textsuperscript{5}. 

3.13 Analytics with Piwik\textsuperscript{18}

Together with the open-source analytics platform Piwik, the Moodle plugin Analytics can be very useful. Once the plugin and the Piwik platform have been installed properly, a lot of information about different things, like the amount of views of specified sites or activities, which actions were taken, visitor profile etc can be displayed. The Piwik platform shows all the information using widgets on the dashboard. Different information are displayed using tabulation or graphs depending on the selected widget. The Piwik Dashboard and three selected widgets are displayed in Figure 22, Figure 23 and Figure 24.

\textsuperscript{18} Cf. https://moodle.org\textsuperscript{1}. 

Figure 21: Example of a Course dedication request
Figure 22: Overview of viewed Moodle course pages on a selected day

Figure 23: Visits of a Moodle course over a time period (chart)
Visitor profile

IP:
ID: 47b7d461a62a082
Chrome - Windows 10
Resolution: 1280x1024

Summary
Spent a total of 4 min 21s on the website, and viewed 40 pages in 2 visits.
Converted 0 Goals.
Each page took an average 2.693s to load for this visitor.

First visit
Wednesday, May 17, 2017 - 0 days ago
from Direct Entry

Location
2 visits from Germany

Visit #1 (4 min 21s)
1. Course: ADOxx.org Training
   localhost/course/view.php?id=4
2. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
3. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
4. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
5. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
6. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
7. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
8. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
9. Course: ADOxx.org Training
   localhost/course/view.php?id=4&notifyeditingtonon=1
10. Course: ADOxx.org Training
    localhost/course/view.php?id=4&notifyeditingtonon=1

Figure 24: Visitor profile widget
4  PBL-Setup

The three phases of learning, which were already mentioned in previous Deliverables and are depicted in Figure 25, are design, execution and evaluation. To design the courses the ECAAD Modelling Toolkit was used and for execution and evaluation purpose the Learning Management System Moodle was chosen. In the following section the ECAAD Modelling Toolkit as well as the Learning Management System Moodle will be examined.

Figure 25: Phases of learning

4.1  Learning Design: ECAAD

The ECAAD tool is based on the ECAAD methodology, which stands for Evidence Centred Activity and Assessment Design and is extended from the Evidence Centred Design approach.\(^\text{19}\) Figure 26 shows the dynamic Meta model of the ECAAD tool. Since ECAAD is based on the ADOxx Meta modelling

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\(^\text{19}\) Cf. https://www.adoxx.org\(^\text{U}\).
platform its Meta model contains some predefined abstract classes of ADOxx. These predefined classes are represented by the white rectangles in Figure 26.\textsuperscript{20} The blue rectangles represent classes, which were added during the process of the implementation of the ECAAD tool. In addition all classes, which are labelled with two underscores at the beginning and the end are abstract classes and thus cannot be instanced. However, all classes have one super class namely “\texttt{D-construct}”. Thus existing as well as added classes inherit a bundle of predefined attributes, which cannot be deleted.

Moreover, the grey and yellow rectangles at the bottom of Figure 26 represent the relation classes in the dynamic Meta model of ECAAD. Whereby the yellow rectangles are the relation classes added during the development of the modelling method.

\textsuperscript{20} Cf. https://www.adoxx.org\textsuperscript{v}.
Furthermore, Figure 27 depicts the static Meta model of the ECAAD tool. Similar to the dynamic Meta model, the static Meta model also contains predefined abstract classes included through the use of the ADOxx Meta modelling platform. However, the difference between the static and the dynamic library is that classes of the dynamic library describe the behaviour/processing logic in a model while the classes of the static library are used to describe structural aspects.
The current Version, which is available for download, is the ECAAD 3.1 extended with some features and model types developed during this project. To further develop and extend the current ECAAD version, the ECAAD 3.1 library has to be downloaded and imported to the ADOxx Meta modelling platform.\footnote{Note: The ECAAD 3.1 library is available under: \url{https://www.adoxx.org/live/web/pbl-3.0/ecaad}}

First, before providing a more detailed description of the model types and classes used to model courses, an overview and a short description of the user interface of the ECAAD tool will be provided. Figure 28 depicts the user interface of the ECAAD tool. The model group explorer window, where all the model groups and models are listed, is located on the left side under the main menu bar. By right-clicking on a model group folder and selecting the option “New” all available model types will appear. The extracts of the six model types, which were used to model the three use cases, are shown in Figure 28. The first model type called “Overview map” is intended for giving a broad overview of the course by modelling all the phases. For a detailed modelling of learning activities and learning assessments occurring during a phase, the “Learning progression map” can be used. The third model type, the “Resource model”, can be applied to model all the resources used in a course. Furthermore, the “Role model” is an appropriate model type to model the actors, who are involved in a course. In addition, all the competencies, which are needed for or can be acquired during a course, are modelled using the “Knowledge state map”. The last model type depicted in Figure 28 is the “Tool pool”, where all the tools used for the support of activities and assessments can be modelled. A more detail description of the six model types will be provided in the following section.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{ecaad.png}
\caption{ECAAD static Meta model}
\end{figure}
At the beginning it is advisable to provide a broad overview in order to get an idea of the course. For this purpose the Overview map model type is useful. The Overview map model type contains nine classes, which enable the modelling of the main phases within a course. The class “Phase” represents the particular phase of a course. Each Phase object includes a notebook partitioned with chapters. The notebook is not an instance of a modelling class, but a representation of selected attributes of an object. Moreover, the attributes can be of different types like e.g. String, Integer, Time, Enumeration etc. The values of the attributes can be edited to provide some information about a particular object or to reference to other objects. Symbols for attributes, which contain the reference to other relevant models, are displayed directly on the object to enable a fast access of these models and to enhance the overview. Figure 29 depicts an instance of the Phase class with the corresponding notebook. The icons placed on the object allow a linkage to particular model types, which will be described below. In addition, the graphical representations of all the modelling classes used in the Overview map are depicted below the instance of the Phase class in Figure 29.
The Tool pool model type contains two classes namely “Tool” and “Block”. The Block class is used to group the tools applied in a phase of a course and the Tool class is intended for representing the tools. Figure 30 illustrates a collection of tools within a block, which in this case represents a phase of a project.
The Learning progression map is intended to give a detailed picture of all the learning activities and assessments conducted during a particular phase. Thus, from the nine classes in the Learning progression map two classes are crucial namely the “Learning Activity” and the “Assessment method” class. Figure 31 shows an extract of a process in the Learning progression map and the notebook of a Learning Activity object.

![Learning progression map](image)

**Figure 31: Learning progression map: Graphical representation of classes + model extract**

Moreover, similar to the Phase class above, symbols for the direct reference to other objects are displayed if the particular attribute is not empty. However, the direct references in a Learning progression map are more detailed. For example, on the one hand the wrench icon on a Phase class (see Figure 29) references to the Block class object within the Tool model, which groups the tools used in all activities of a phase. In contrast, the same symbol on Learning activity objects (see Figure 31) references to the objects of the Tool class used during a particular learning activity.

In addition, a Learning Activity object can be of five different types namely “Informative”, “Collaborative”, “Assessment”, “Reflective” or “Other” and depending on the selected type the instance changes its colour.
The Assessment method instance shown in Figure 31 represents a Quiz with a direct linkage to the corresponding Tool object, which holds all the crucial information of the tool used. Additionally, all the graphical representations of the classes available in the Learning progression map are depicted on the left side of Figure 31.

Furthermore, the name of the actors or the groups conducting the activity is directly visible on the surface of a Learning Activity object and the symbol within the blue area is a reference to the Role model (see Figure 31). In the Role model all the actors and groups involved are modelled using three classes namely “Group”, “Actor” and “Role”. The graphical representations of the three classes of the Role model are depicted in Figure 32.

![Figure 32: Graphical representations of the Role model classes](image)

To provide an overview of all the resources required during the execution of a course the Resource model can be used. This model type contains three classes namely “Block”, “Service” and “Document”. The class Block is useful to group all the resources, which can be represented by the objects of the classes Service or Document. Figure 33 depicts an example of a Block instance, which clusters several Document objects.

![Figure 33: Resource model: Graphical representations of classes + model extract](image)

The Knowledge state map model type, depicted in Figure 34, contains two classes namely a “Knowledge state” class and a relation class “decompose”. Moreover the Knowledge state object
can be of six different types namely “Knowledge”, “Attitude”, “Fact”, “Concept”, “Skill” and “Learning goal” and thus can change its appearance depending on the selected type. In addition, ECAAD offers a special functionality for the Knowledge state map model type. After creating a model the layout can be rearranged to a specific tree layout by just one click.

As depicted in Figure 29 there are two icons, which provide the possibility to directly access a Knowledge state map model from a Phase class object in an Overview map. However, the difference between the two symbols is that the red target links to the initial state respectively to the requirements for a particular phase. Whereas the white question mark with the blue background provides a linkage to the final state, meaning the expected outcomes of a particular phase.

Since the ECAAD Modelling Toolkit is based on the ADOxx Meta modelling platform, some functionalities of ADOxx are inherited. This includes among others the possibility to conduct queries using the ADOxx Query Language (AQL). Figure 35 shows a query example conducted on an Overview map, which once executed returns all the objects of the class Phase with a not empty “Referenced resources” attribute. Thus all the objects, which contain a reference to an object in a Resource model, are returned.
Furthermore, all the models created in ECAAD can be exported and imported in a .adl (ADOxx Definition Language) as well as in a .xml format. The XML Document Type Definition (DTD) used for the import and export of models in a .xml format is automatically created during a XML export of a model and thus can be viewed thereafter.

4.2 Learning Execution: Moodle

For the execution of the three Use cases the Learning Management System Moodle was chosen. Moodle allows to set up courses and to manage them easily. Nevertheless, not every user in Moodle has the rights to edit the content of courses or to use reports and other useful functionalities of Moodle. The main role is the “administrator”, who can assign roles to other registered users and use all available functionalities on the platform. However for creating and editing courses the roles “manager” and “teacher” are sufficient. In the following section a short description of a course set up in Moodle 3.2 will be provided.

The first step to set up a course on Moodle is the course creation using the “Site administration” panel. Figure 36 shows the course creation page, which consists of nine segments in the Moodle 3.2 version. The most important segment for the creation of a course is the “General” section. In this segment the name, the category, the start and end date, the visibility as well as the course ID can be determined. The remaining segments are Description, Course format, Appearance, Files and uploads, Completion tracking, Groups, Role renaming and Tags.
Figure 36: Moodle: Course creation page

An example of the main page of a created course is depicted in Figure 37. The amount of phases in a course can be easily adjusted by using the increase or reduce button on the bottom of the main page. However, to be able to see and use these buttons the editing option must be turned on. Naturally, every section can be edited, thus e.g. renaming or hiding of sections is not a problem in Moodle.
Furthermore, for adding content and functionalities to the course, Moodle offers two groups of features namely activities and resources. The features in the activities group are intended to enable and ease the interaction among the participants including the teachers.\textsuperscript{22} The features in the resources group are used to add files, folders, web links etc. However, some features are default and thus come with the installation of the platform. Though, since Moodle is an open-source platform a lot of additional plug-ins exist, which just need to be downloaded and installed in order to use them on the platform.

Moreover, Moodle provides the adding of blocks, which are features that provide different functionalities for courses. Other than activities or resources, blocks are not used for a particular phase but for the entire course. Hence, blocks do not appear within sections, but next to the course overview. Further, like activity plugins, additional blocks can also be added through downloading and installing them. Figure 38 shows an extract of the selection menu for activities or resources and Figure 39 depicts an extract of the selection menu for blocks.

\textsuperscript{22} Cf. https://docs.moodle.org\textsuperscript{w}. 
Figure 38: Moodle: Activities and resources selection menu
4.3 Comparison: Learning Design – Learning Execution

In the following section a comparison of the Learning Design environment and the Learning Execution environment will be presented on the basis of examples.

The first example is the overview of the ADOxx.org training (see 5.1), which is divided into seven phases. To model the phases in ECAAD the Overview map can be used. In Moodle the seven parts of the ADOxx Training are represented using the sections functionality. Figure 40 shows a comparison of the design and execution environments regarding the seven phases of the course.
Furthermore, the resources and tools needed for the execution in every phase of the course are modelled in a manner to ease the transformation from design to execution. In context of Moodle the term “tool” is used in this document for all kind of learning assistant, assessment or analysis modules or plugins, which either are included in Moodle or can be integrated. Figure 41 shows an example of a phase of the ADOxx.org Training. The Tool pool model and the Resource model containing the corresponding tools respectively resources for a phase are directly referenced from the phase object. Thus, the match of a phase and its corresponding tools and resources is already done in the design environment making the transformation to the execution environment easier. Moreover, to assure that all tools or resources have been transferred to the Execution environment, the tool and resource classes have an attribute, which checks whether a particular object was transferred or not. If a transformation of a particular resource or tool to the Execution environment did not happen, then the object will turn red.
Moreover, similar to the tools and resources the competencies are also modelled in a way to ease the transformation to the execution environment. The structure of the competencies models in ECAAD can be directly adopted to issue competency frameworks for the courses in Moodle. Figure 42 shows a structured extract of a competency model in the design environment and the corresponding part in the execution environment. In addition, Moodle provides an import and an export of the competency framework in .csv format. Thus, ECAAD can be easily extended by a functionality which collects all the required data of the competencies and provides an importable package for Moodle.
Finally, the Knowledge state map in ECAAD, where all the goals and skills for a course are modelled and structured plus the information gathered through the learning analytics tools in the execution environment can be useful for the third phase of learning namely the evaluation. Based on the interpretation of the information and the comparison of goals set and goals reached decisions can be made whether to make changes in the Design environment.

Figure 42: Extract of the ADOxx.org Training competencies (Design – Execution)
4.4 Moodie Tools for the PBL approach

A variety of PBL and LA tools aim to trigger active participation for the students and allow increased monitoring for educators. The following sub-sections describe the tools to be used and present their functionalities.

4.4.1 Forum

The forum is an already installed activity within the Moodle platform and aims to allow exchange of ideas and discussions between students and between educators and students. As shown in Figure 43, students can participate in various discussions, post comments and reply to other students’ posts.

![Forum activity on Moodle](https://docs.moodle.org)

The Forum activity also allows the inclusion of files such as images and media, and also enables rating of posts from educators and students. Students and educators can also activate forum tracking so that they will be informed on new posts for the forums they are monitoring.

Educators can initiate discussions in one or multiple forums and also encourage students to brainstorm, share ideas or plan their problems and tasks and monitor their progress. Forum interactions are an essential part of the Moodle course as multiple LA plugins gather and process data generated from forums in order to identify engagement, participation, social networks etc.

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23 https://docs.moodle.org

4.4.1.1 Forum Graph

Forum graph is an additional plugin that can be installed within Moodle, and aims to analyse interactions in a Forum activity and create a force-directed graph, as shown in Figure 44.

Each node in the above Figure represents a specific user; thus, the size of the nodes included in a graph depends on the posts created by each user. The graph represents educators and students in different coloring in order to facilitate distinguishing between posts made by the students and by the educators. The graph provides the possibility to toggle a node and view the user’s full name, as well as to click on a node and show a popup window with the specific posts or replies the user has contributed in the forum.

Each edge represents an interaction between two users, e.g. a reply to an existing post. Edges can have different sizes in thickness as the number of interactions between the two users increases.

Finally, the plugin includes a table that provides information on the total number of discussions and replies within the forum, and the top three users with the leading activity.

24 https://moodle.org/
4.4.2 Checklist

The Checklist activity is an additional plugin that needs to be installed within Moodle, and aims to allow the creation of to-do lists for students and educators to plan and monitor their work, as shown in Figure 45.

![My checklist](https://moodle.org)

**Figure 45: Checklist plugin for Moodle**

Students can add items as tasks to be completed, indicate if they are private or public and structure hierarchy of the list items. Each item can be checked as optional, indicating its importance to the work load. Students are presented with a bar that shows how far they have progressed within a specific required or optional task.

The checklist plugin also allows students to add notes in their items for further descriptions as well as dates as deadlines. These dates can be exported to the calendar for external usage. Additionally, students can receive comments from educators on each student’s items, and choose different colours for each item for easier classification.

The progress of each checklist can be exported to the gradebook for assessment.

4.4.2.1 Progress bars of check-lists

As shown in Section 4.4.2, the progress bars that are included in the Checklist plugin, can facilitate educators to detect ongoing progress per group. Based on how far each group has progressed, educators can provide scaffolding or warnings or post comments within the checklist’s items in order to encourage students to proceed with their tasks.

Additionally, as shown in Figure 46, educators can monitor each student’s posts within the activity and identify any cases of low participation.

4.4.3 GISMO

The GISMO plugin needs to be installed within Moodle, and aims to provide useful visualization of students' activities in online courses for educators, as shown in Figure 47.
GISMO allows educators to view students’ attendance in the various courses within Moodle, as well as frequency of access to resources and submission of assignments. GISMO provides graphs as visualizations, which enable educators to have an overall overview of the entire class and thus get a more concrete idea of the progress of each class for a specific period in time.

4.4.4 Student folder

Student folder is a plugin that needs to be installed within Moodle, and allows students to upload various documents that can be visible to the teacher, as shown in Figure 48. This aims to enable publication of students’ work and reports and also promote exchange of knowledge amongst group members and also between the group and the educators.

![Figure 48: Student folder plugin for Moodle](https://moodle.org)

26 https://moodle.org
Within the student folder plugin, participants can upload their documents and allow visibility for other students or require approval from the educators before the documents become visible. The tool also allows import of documents from the assignment activity of Moodle within a group’s folder.

This tool aims to assist students in storing their reports or their interim work, exchange knowledge and upload their literature findings during the various phases of the PBL model.

### 4.4.5 Social Bookmark

Social Bookmark is a plugin that needs to be installed within Moodle and aims for students to be able to add bookmarks and create tags for easier bookmark discovery, as shown in Figure 49. Students can also add ratings to each bookmark, indicating how significant or relevant it is to the literature search.

![Image of Social Bookmark plugin for Moodle](https://moodle.org/b27)

Figure 49: Social Bookmark plugin for Moodle

This way, students can gather, record and share the literature sources they have identified for the formulation and solution of their problem, and search easily through the sources in order to study the relevant literature. In order to further assist this process, the Social Bookmark plugin creates a tag cloud with the tags inserted, which allows students to explore the existing bookmarks more quickly and based on specific topics.

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27 [https://moodle.org](https://moodle.org)
4.4.6 Wiki

Wiki is a standard plugin that is already installed in all versions of Moodle as an existing activity. The functionality of the Moodle wiki is the same as in any standard wiki applications, i.e. it is a collection of collaboratively created web pages, as shown in Figure 50.

With this activity, students can co-create reports and documents that are shared within the group and also with the educators, ensuring interim monitoring of their results and feedback on their progress.

4.4.7 Assignment

Assignment is a standard plugin already installed within Moodle as an activity. Using this plugin, students can upload their work which is to be reviewed and assessed by the educators, as shown in Figure 51.
Assignments can have specific deadlines and also receive feedback from educators upon inspection. Moodle allows two types of assignments submissions, including:

- **Online text**: Text written on an editor for educators to review. This text can have specific word limits set by educators, and the editor provides a warning to the students if they exceed it.
- **Files**: Students can prepare their reports or documents in specific file formats and upload them within the assignment activity. Educators can indicate the type of files accepted, the number of file submissions allowed as well as file size per assignment.

Moodle also allows specific types of feedback from the educators towards the students regarding their assignments, including:

- **Comments**: Educators can write comments directly on the students’ work when they are using the online text functionality.
- **Offline grading worksheet**: A worksheet is provided to the educators to download offline and add grades and comments for students’ submissions. Once filled, educators can re-upload the worksheet and publish the grading results.
- **Feedback files**: Educators can create files with specific feedback on the assignments and share them with the students.

### 4.4.8 Mind map

The Mind map plugin needs to be installed within Moodle, and aims to allow students to create multiple mind maps on any topic, as shown in Figure 52.

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28 [http://iits.haverford.edu](http://iits.haverford.edu)
Students can use this plugin in order to brainstorm their ideas for the problem and solution formulation, and also analyse the problem into concepts for better understanding. This process improves their critical thinking skills and fosters abilities such as breaking down problems and ideas generation.

4.4.8.1 Mind map graph

The graph created within each mind map allows educators to monitor and assess the work carried out per group and per student. This visualization enables educators to make decisions on the progress of each group and make necessary adaptations when they see fit, e.g. if a group has created few concepts, if the concepts are not relevant to the main topic, if the relations between the concepts are incorrect etc.

4.4.9 Workshop

Workshop is an activity already installed within all versions of Moodle. This activity aims to allow peer assessment of documents and exchange of knowledge, as shown in Figure 53.

29 https://www.packtpub.com
The workshop is a student-focused activity and enables students to submit their own work for assessment as well to assess other students’ work. Thus, the final grade of a student through this activity includes the assessment of the work they submitted as well as the quality of their assessment of other assignments.

This process facilitates students in gaining skills such as critical thinking, evaluation, examining evidence, application of knowledge etc.

### 4.4.10 Adaptive Quiz

The Adaptive quiz plugin needs to be installed within Moodle and aims to allow educators to create quizzes that measure students’ comprehension skills and are adapted based on their answers.

Each question is scored with a level of difficulty so that educators can adapt the quiz accordingly, since they choose the questions based on each student’s abilities. If a student answers a question correctly, then they are provided with a question of greater difficulty, whereas if they answer incorrectly, they are presented with an easier question. The quiz stops when the student’s comprehension is determined to be at the appropriate level.

An example of how educators can monitor an adaptive quiz’s attempt is shown in Figure 54.
Viewing this Figure, educators can make decisions on future quiz adaptations and what scaffolding and mentoring techniques they can employ to help students that seem to be struggling even in the easiest questions.

4.4.11 Moodle reports

Moodle supports a number of reports that are available for educators in order to monitor their courses’ progress. These reports take advantage of the data recorded in the platform’s database and generate different visualizations or tables with information available for educators and Moodle administrators.

4.4.11.1 Overview statistics

This report generates a number of graphs that visualize information about the entire platform and per course. Some of the available visualizations are presented in Figure 55 and Figure 56.
Educators can consult the generated visualizations and make decisions on re-designing their e-learning platform and courses as well as monitor students’ access frequency.

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31 https://moodle.org
32 https://moodle.org
4.4.11.2 Events Graphic Report

The Events Graphic report aims to provide graphical representation of users’ activity within courses, as shown in Figure 57.

Figure 57: Events graph report
Educators can identify users with low activity within courses and make necessary decisions to encourage their active participation.
5 Deployment and case studies

5.1 Deployment

The ECAAD tool is based on the ADOxx Meta-Modelling Platform. Thus, the installation of the ECAAD tool requires a Windows operating system whereby the operating system should not be older than Windows XP. However, it is also possible to use ECAAD on other operating systems by using a virtual machine.

For the installation of the tool the ECAAD installation package has to be downloaded first. The installation package contains among others a setup.exe file, which has to be executed in order to start the installation. In the first step pre-checks and installation requirements are conducted and the required components are shown in a window. Furthermore, if not yet installed, the SQL database engine with a dedicated instance will be installed during this step. After all components were installed, the tool itself needs to be installed. In order to ease this process a setup wizard is started. In the following custom setup a selection of the features to be installed, a creation of a new database and the definition of an installation location is handled.

Moreover, for those who want to use the existent functionalities but also prefer to have the possibility to be able to extent the tool, a second option is provided. In this case not the tool, but the ADOxx Meta-Modelling Platform needs to be installed. Since the ADOxx Meta-Modelling Platform is the basis of the ECAAD tool the installation steps are very similar. In order to use the ECAAD tool its library needs to be imported using the ADOxx Development toolkit.

The Moodle instance set up for the trials of the use cases runs on a server using the Linux Ubuntu 16.04 operating system. The version of Moodle used is 3.2. Furthermore the installed HTTP server is Apache 2.4.18. Since Moodle is based on the scripting language PHP the installation of the PHP module for the Apache server is required. The installed PHP version is 7.0. In addition the database for Moodle is based on MySQL.

5.2 ADOxx.org Training case study

The first case study is based on the ADOxx.org training, which is one of the three use cases modelled with ECAAD. The ADOxx.org training is applied as a technical use case to test the functionalities and tools of the environments.

The ADOxx.org training is provided by the BOC and is conducted in three days. Figure 58 shows the structure of the training within ECAAD. The models are divided into five model groups depending on the model type. The first model group named as “Processes” contains models of two types namely the “Overview map” and the “Learning progression map”. The overview of the training phases is provided in the first model.
The ADOxx.org Training can be divided into seven phases namely introduction, OMiLAB introduction, introduction to ADOxx, modelling language implementation on ADOxx, mechanisms and algorithms implementation on ADOxx, simulation with ADOxx and development services. Figure 59 depicts the seven phases of the training modelled in ECAAD.

Furthermore, the additional models in the “Processes” model group, which are of type “Learning progression map” show the detailed activity and assessment sequence in particular phases. Figure 60 shows an example of a sequence of activities and assessments in a Learning progression map of the ADOxx.org Training and the connection between the object of the Overview map and the Learning progression map. The attribute of the Phase class is of type Inter-model reference and thus the object can hold references to a specified model type within this attribute. Moreover, because the particular attribute is not empty the Learning progression map icon appears above the Phase object. In this way it is immediately visible that a detailed description of the activities in a particular phase is included within the model.
The second model group contains the resources, which are used during the execution of the ADOxx.org training. Figure 61 shows the corresponding model. The grey Block objects are used to represent the particular phases of the ADOxx.org training and the Document objects represent the resources. In addition, the Document class attribute “Referenced document” allows to type in the link or path of the resource and thus provides a direct access of it.
The third model group is intended for the models of all roles, actors or groups involved in the ADOxx.org training. Figure 62 depicts the Role model instance for the training. The Group objects are used to represent the different groups involved and the Actor objects represent the actors within different groups. In the case of the ADOxx.org training mainly three groups are involved namely the participants, the OMiLAB instructors and the ADOxx.org training instructors. Further, other than e.g. resources, the objects of the Role model cannot be accessed directly from the Phase object in the Overview map. That is because the actors within the role model are aggregated in groups and not in phases. However, it is possible to reference from Learning Activity objects to objects of the Role model. An example of such a reference for the ADOxx.org training is also shown in Figure 62.
The fourth model group is a container for all the models dealing with competencies within the ADOxx.org training. These competencies include knowledge, attitudes, facts, concepts, skills and learning goals. Figure 63 shows a Knowledge state map model instance with all the competencies for the training. The structure of the model is based on a directed tree layout (horizontal) and consists of four levels. The Knowledge state object on the highest level, which represents all competencies of the ADOxx.org Training, is the parent knowledge state of all competencies on the second level. The competencies for the different sections of the training are depicted on the second level. The goals respectively sub-goals of the sections are on the third and fourth level.

The fifth model group holds the instances of the Tool pool model type, which is used to model the tools applied during the ADOxx.org training. Moreover, in the model depicted in Figure 64 the Block objects illustrate the seven phases of the training and the Tool objects within the blocks represent the tools or methods used in the particular phases.
5.3 Audio-Visual Experiments case study

The second case study is based on a 5th semester Medialogy Bachelor project called “Audio-Visual Experiments” at the University of Aalborg. The project is based on the PBL approach.

The project is provided by the AAU and endures one semester.

Figure 65 shows the structure of the project within ECAAD. Similar to the ADOxx.org training above the models of the project are divided into five groups.
In this case, since the project is based on the PBL approach, the Learning progression map models represent eight phases starting with problem formulation. Figure 66 depicts the nine phases of the project including the introduction. In addition, the connection between the Phase object and the activity and assessment sequence of the “Reporting” phase is shown. The reference between the Phase object and the Learning progression map model is made using the class attribute “Referenced Learning progression map”, which is of type Inter-model reference.
The Resource model contained in the second model group shows a possibility of an additional segmentation of phases. Accordingly, if it is necessary to split a phase into several topics containing resources this can be done by placing additional Block objects within a Block object. Figure 67 shows an example of such segmentation for the introduction phase of the Audio-Visual Experiments project. The remaining resources used in the project are further divided and allocated to the corresponding phases of the PBL-approach. Thus the Resources model contains nine main blocks.
The next model group is intended for the roles involved in the Audio-Visual Experiments project. The three main groups of the project are the semester coordinators, the supervisors and the students. In the Role model in ECAAD each group is represented by the Group object. Further for a better matching of the competencies of an actor to the competencies needed for conducting or teaching a phase or activity, it is possible to add competencies to the Actor objects by referencing to the Knowledge state map. This function should ease the assignment of teachers to certain phases or activities. Figure 68 depicts an example of an actor object with the “Name” attribute value “Supervisor 1” and the competencies for conducting the group formation and the problem formulation phase. Nevertheless, it is only possible to add competencies to the actors with the role “Teacher”. For the role “Student” the attribute “Competencies” is disabled.

Figure 67: Example: Additional topics within a phase in the Resource model
The second last model group in the ECAAD structure contains a model of all the competencies of the Audio-Visual Experiments project. In this case the structure of the competencies within the model is represented by a radial tree layout. Following this, the Knowledge state object in the middle of Figure 69 represents all competencies included in the Audio-Visual Experiments project. Further, the object decomposes into two another objects. The object below represents all the competencies of the PBL approach while the object above holds all the competencies of the Audio-Visual Experiments course module. However, the layout can be fast changed to another tree structure by using the ECAAD “Layout” functionality.
Figure 69: Audio-Visual Experiments project Knowledge state model

The last model group of the second use case hardly differs from the last model group of the first use case. It is based on the same principle namely to use the Block object of the Tool pool model type to model the phases of the project and the Tool objects to depict the methods or tools used. However, the phases and tools included obviously differ from those in the first use case. Figure 70 shows the Tool pool model of the Audio-Visual Experiments project.
5.4 Information Systems Analysis and Design case study

For the third use case the Information Systems Analysis and Design (ISAD) course provided by the University of Macedonia was used. The ISAD course is divided into lectures and a project part and is a semester course. The amount of lectures, which take place weekly, is thirteen. Figure 71 depicts the model group of the ISAD course in ECAAD. The structure is similar to the two previous use cases.
Further, for the project part of the course the PBL approach will be applied. Moreover, the lectures of the course are modelled as learning activities in the Learning progression map models of the first model group. Figure 72 shows the phases of the project part modelled using the Overview map model type and the activities and assessment methods of the problem formulation phase in a Learning progression map. In addition, after every lecture the understanding of the content is examined using a quiz as an assessment method.

Figure 72: Phases of the ISAD project and problem formulation activities

The content of the Resource model in the second model group is similar to that of the second use case meaning that the Block objects are representing the same phases based on the PBL approach, but the resources represented in the model differ. Figure 73 shows an extract of the Resource model respectively the resources of the analysis phase.

Figure 73: Extract of the Resource model of the ISAD project part

The two main groups involved in the ISAD course are teachers and students. Both groups are represented in the Role model of the third model group. Since group formation among the students is an important aspect of the PBL approach, it is possible to model further groups within a main group. Thus, the model provides a graphical overview of the students’ groups. Figure 74 depicts the two main groups of the course whereby the students’ group is further decomposed into different groups formed by students.
For the knowledge state map of the ISAD use case the horizontal directed tree layout was used. Furthermore, the ISAD competencies are decomposed into the course objectives and the PBL competencies. The Knowledge state object, which represents the course objectives, further decomposes into all the goals of the course. Moreover, the Knowledge state object, which represents the PBL competencies, decomposes into all the particular competencies of the PBL phases. Figure 75 shows the Knowledge state map model of the ISAD course.

The fifth model group of the ISAD use case holds the Tool pool model containing all the tools for the course. Beyond that, similar to the Audio-Visual Experiments project use case, the phases modelled within the Tool pool model are based on the PBL approach. Thus the tool pool models of both use cases are very similar and differ only regarding the modelled tools.
6 Conclusions

The present document reported the identified PBL modules and tools, which collect data that derives directly from the PBL_LA educational approach, as well as the Learning analytics tools, which analyze the collected data. In addition, the purpose was to integrate the selected tools into the e-learning space of the Community of Practice platform, which is based on an existing LMS environment, namely Moodle. Furthermore, the model-based approach ECAAD, which is used to design courses, was presented. Accordingly, ECAAD and Moodle are the two main environments presented in this deliverable, which are intended to cover the three phases of learning - namely design, execution and evaluation.

What is more, for future trials three use cases - namely the ADOxx.org training (BOC), a project on Audio-Visual Experiments provided at the University of Aalborg, and the project part of the Information Systems Analysis and Design course provided at the University of Macedonia, were selected and introduced. Moreover, the models of the use case created in ECAAD as part of the design phase were used to set up the courses in Moodle in order to have them ready for the execution.

Overall, the following objectives were targeted:

- **To identify and analyze existing Learning Analytics tools**
  A selection of Learning Analytics tools mainly for the Open-source learning platform Moodle was presented in the 3rd section of this document.

- **To deploy the appropriate Learning Analytics tools for the needs of PBL_LA educational approach**
  Section four of this deliverable offers a description of some Learning Analytics tools, which seem to be appropriate for the PBL_LA educational approach.

- **To install the CoP platform and integrate the configured tools into the e-learning space**
  For this purpose the Open-source learning platform Moodle was installed and all the tools described in this document were integrated into the installed Moodle instance.

- **To integrate and configure the model-based approach on continuous learning and skills assessment**
  Here the model-based approach and tool ECAAD (Evidence Centred Activity and Assessment Design) was integrated. Furthermore the tool is being continuously developed in order to fulfil upcoming requirements.
Bibliography

Online Sources