

# Cross-university question exchange platform based on Moodle LMS

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## ABSTRACT

During the projects "Profilgebundene Wissens Checks 2.0" and "StudiPortal Brandenburg" funded by the European Social Fund (ESF), a Moodle-based question exchange platform (QEP) was developed and tested between 2018 and 2022. Up to eight universities in the state of Brandenburg Germany worked together in both successive projects. The work packages included the development of online subject quizzes (online self-assessments) to help prospective students match their individual level of apprehension with the knowledge required at the beginning of their studies. Depending on the obtained results, e-learning units with the necessary subject understanding were provided. An important component of the project is the question exchange platform, on which the questions from the partner universities were made available for exchange in order to serve as a basis for assessments used across the universities, primarily in the fields of Science, Technology, Engineering and Mathematics (STEM) as well as economics, law and psychology. Besides the cross-university access to the questions, the platform offers many other advantages such as extensive search options, key wording (tags), and import and export functions for the various systems of the university partners. New Moodle plugins have been developed specifically for these functionalities to extend the Moodle question bank for importing questions from other systems with metadata, searching for questions via metadata, keywords and exporting questions to other Question and Test Interoperability Specification (QTI)-based LMSs. The platform also served as a project website providing all relevant information about the project and the partner universities.

**Keywords:** higher education, self-assessments, question-bank, databases, metadata, LMS Moodle, platforms, plugins

## 1. INTRODUCTION

There are many freely available repositories for Open Educational Resources (OER); an overview of the initiatives in Germany, arranged by the federal state, can be found on the website of the OER Repo AG [1]. At universities in the state of Bavaria, for example, OPEN VHB [2] is used for the exchange of smaller learning units for integration at course level and Twillo [3] is used in the state of Lower Saxony. The LMS Moodle also offers the possibility of linking learning units in the Moodle course via the Edusharing plugin [4]. Our research has shown that there has not yet been a database for the secure cross-university exchange of categorized questions with metadata in STEM and advanced undergraduate subject areas as a basis for creating online assessments and exams. In the course of the two projects, a new unique system has been created and tested, which could be used throughout the state of Brandenburg and in Germany in the future. Based on the concept [5], the QEP [6] was implemented with all important components in the first part of the project, then further developed in the second part of the project based on the results of the first test phase and filled with the categories and questions previously agreed between the project partners. In the first test phase, within the scope of the project, access to the QEP and the question bank with the specific user roles, the import and export of questions, and the search of questions by keywords (tags) were tested. In a second test phase, the design, especially the mobile access to the website/QEP and the usability and handling, was tested and suggestions for improvements were elaborated. The final third test phase took place in the second project after two extensive user training sessions on how to use the platform and how to create assessments on the platform. In addition to the import and search of questions in the QEP, the creation of tests from the QEP tasks on the QEP or by exporting them to the respective target systems was tested. Moodle [7] is the main target system used at the partner universities. The TH Wildau mainly uses Questionmark Perception [8] for tests

and e-exams, while at the BTU Cottbus – Senftenberg, for instance, for highly secure and flexible online exams is LPLUS [9] used. Both systems are based on the QTI [10] standard for question exchange, which, depending on the version of the system, has not been completely implemented or it has been but in an adapted form and requires special adjustments, which we have partly tested and developed for some selected question types in our developed QTI Moodle Plugin [11]. During the course of the projects three special Moodle plugins were developed. The first plugin is for question import and export with metadata and extension of the question bank, the second one is for searching questions by metadata and the third one is for sharing questions with QTI-based examination and LM systems. Based on the concept of the platform presented at InnoEducaTIC 2020, we present in this publication the achieved implementation and testing of the platform as well as the improvements after the respective testing phases.

## 2. COMPONENTS OF THE PLATFORM

In this chapter we describe the components of the platform in more detail, especially the customized components. The basis for the QEP was a Moodle LMS in the current version 3.9. In order to accomplish the necessary import and export of questions from different systems or into different systems, the question bank integrated in Moodle was extended by three plugins. Firstly, the plugin for adding metadata to each question. Secondly, the plugin for searching questions by their metadata, which was also published in a light version in the Moodle community [12] and thirdly, the import or export of questions in QTI-based systems such as Questionmark Perception. Since the QEP served also as the website for the project, the template was also adapted accordingly, and after a second test phase it was also specifically adapted for mobile device access. The platform is accessible via common web browsers. During the second phase of the project, access through mobile devices was improved in particular. After logging in, authorized users can access the question collection, import, search, and export questions, and create essays from the questions. To carry out the requested requirements, several plug-ins were used, adapted, created, newly developed and integrated into the platform (see figure 1).

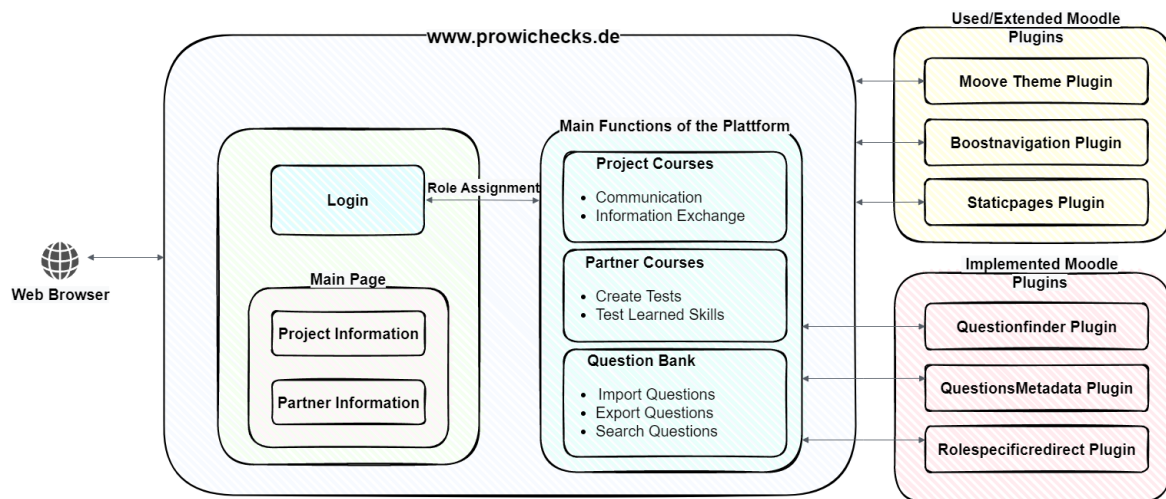


Figure 1. Basic structure of the question exchange platform.

### 2.1 Project Website

The website of the “StudiPortal Brandenburg” project was integrated into the question exchange platform in 2020, when the first version of QEP was launched. Before that there existed only a normal project website with information about the project. The main idea was to link the project website with all the information about the project and the project partner universities to the question database, and thus to develop a major platform for communication and exchange among all Brandenburg universities. On the one hand, all users see the information about the project and the partners, and on the other hand, after logging in to the platform, the authorized users of the project have access to the question bank of the platform. Beside the design implementations, this platform was expanded and provided with various courses. For the purpose of making all of this possible there are some open-source plugins that are used and improved like: “staticpages”, “boostravigation”, “move theme” and new developed plugins like: “questionfinder”, “moodle question metadata” and rolespecific redirect”.

## 2.2 Project Courses

The provided project courses are available for all assigned employees from every partner university. There is one IT course for all project members who are assigned to maintain the IT assignments. This course was used specifically for IT meetings to exchange information and give feedback for the 3 test phases. In particular, during the time of the pandemic and home office working, it was possible to exchange information about each partners' accomplishments via the BigBlueButton video conferencing system connected to the platform [13][14]. Another course was created with its purpose to maintain the communication channels between the partners of the project. Further courses were also created in order to provide all the members with enough training materials or to collect and organize information exchange for the project coordination.

## 2.3 Partner Courses

Apart from the main partner courses where every project member has access, there were also specified courses created for each partner university (see figure 2). The main idea behind these courses is to give the members of this project the opportunity to test the platform and the learned knowledge from the provided trainings by creating their own tests with the already shared questions from the question bank.

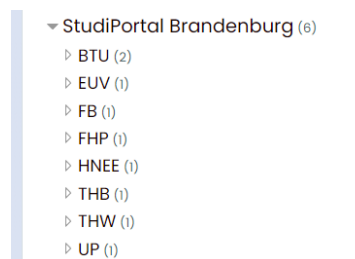


Figure 2. Course areas with courses for project partners.

## 2.4 Question Categories and Question Types

As shown on figure 3 there exist a variety of different categories and subcategories for questions on the cross-university question exchange platform "StudiPortal Brandenburg". Apart from all STEM categories, additional categories have also been created. Numerous question types and interfaces to other LMS systems are available and expandable. In addition to the basic question types such as multiple choice or the possibility to fill in a blank, there are also special question types for mathematics and computer science, which have been developed in the Moodle Community especially for higher education.

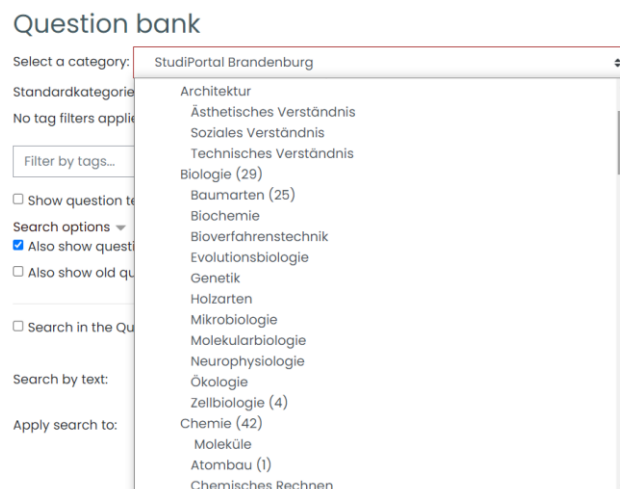


Figure 3. Categories questions in the question bank.

## 2.5 Question Import

The interface for import of questions to the database was implemented based on the Moodle interface. Throughout this project, as planned at the beginning, the functionality for importing questions and their metadata, see figure 4, as well as the editing of the already existing metadata, was also created.

▼ Metadaten: ?

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Zielgruppe		<input type="text"/>
Hinweise		<input type="text"/>

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Figure 4. Import Metadata Form.

## 2.6 Question Export

During the exporting process, a question can be converted from Moodle format to QMP (QTI) format to use in examination systems like Questionmark Percetion or LPLUS. For this purpose, this tool was to be integrated directly into Moodle with the help of a newly created plugin for managing questions with the Moodle XML format [11]. The export function has the functionality to export not only whole categories of questions but also precisely selected ones, like collections of questions across categories, by adding these into a “basket” and letting the user to decide which questions will be exported at the end (see figure 5).

<input checked="" type="checkbox"/> .. Nutzung	Edit ▼	Marcus Fabian 25. Februar 2022, 08:55	Marcus Fabian 25. Februar 2022, 08:55
<input type="checkbox"/> .. Zellen	Edit ▼	Marcus Fabian 25. Februar 2022, 09:48	Marcus Fabian 25. Februar 2022, 09:48
<input checked="" type="checkbox"/> .. Zellwandaufbau	Edit ▼	Marcus Fabian 25. Februar 2022, 09:48	Marcus Fabian 25. Februar 2022, 09:48

20 pro Seite anzeigen

Mit Auswahl:

Löschen Verschieben nach >> Biologie (29) Warenkorb Export

Figure 5. Adding questions to the “basket”.

## 2.7 Question Finder

Additional to the extended functionality of import and export of questions there was also a Moodle plugin created for searching through the question database. Users can search questions based on their title, author, date of creation or modification, but also on the metadata that every question possesses. A light version of the plugin has also been

published in the Moodle Community [12], the extensive version with search function over all metadata is integrated in the QEP (see figure 6).

Search in the Question Bank

Search by text:

Apply search to:  Importer of the questions:  Last modified by:  
 Username  Firstname  Lastname

Search in Metadata:  Name of the question (Questiontext):  
 Author (first Author)  
 University  
 Copyright  
 Tags  
 Question niveau  
 Question type  
 Target group  
 Hints

Date search:

Creation (Metadata):  from: 16 ▾ October ▾ 2022 ▾  to: 16 ▾ October ▾ 2022 ▾

Creation (import):  from: 16 ▾ October ▾ 2022 ▾  to: 16 ▾ October ▾ 2022 ▾

Last change:  from: 16 ▾ October ▾ 2022 ▾  to: 16 ▾ October ▾ 2022 ▾

Figure 6. Extended question bank with questionfinder plugin.

### 3. TEST OF THE PLATFORM

A total of three test phases were carried out in the period from 2020 (first implementation on the basis of the concept) to 2022 (conclusion of the project) and after each test and the evaluation of the test results, the platform was successively further adapted to the needs of the project partners. While the first test phase mainly focused on the basic functions of the QEP, the second test phase was more specifically geared towards the design. The third phase focused more specifically on the creation of assessments from the questionnaire tasks. This chapter provides a more detailed description of the three test phases with the results and the resulting adjustments. In table 1 there is a conclusional result of all three phases which were done by 10 partners from 5 universities.

#### 3.1 First testing phase (23.04.2020 – 19.06.2020)

In the first test phase, in addition to user-friendliness, the access to the platform, the registration process and the forwarding to the question bank were tested. In the general part the design, access rights and roles were verified. During the main part of the survey the question import and export, the input and output of the metadata, the question search, the question shifting and deletion as well as occurred errors were tested.

#### 3.2 Second testing phase (16.10.2020 – 20.11.2020)

After evaluating the feedback of the first test phase, adjustments and improvements of the test system were made. The second test phase was also carried out again with feedback in the course of the test system. After the creation of the categories in the question bank, the import and export of the questions with metadata was tested in particular and there was also the possibility for general feedback for the improvement of the platform.

#### 3.3 Third testing phase (30.09.2022 – 14.10.2022)

For this purpose, a test course was set up on the productive system [6] for all partner universities; the work with the questions from the question bank, primarily from the STEM area, was tested. In the course areas with a course for each university partner was provided, tests were created with questions from the question bank and were exported to create tests on the respective university's own systems. The feedback flows back into the further development of the QEP.

Table 1. Summary table of the results of all test phases.

Questions	Results	Conclusions
<b>Were there any problems while logging in to the platform and finding the database?</b>	Log in worked. Finding the database and other courses was difficult for some users.	There was a plugin created, that redirected users directly to the database. Furthermore, the navigation bar was improved, and all courses were easy to be found.
<b>Were there problems while importing questions to the database?</b>	Some categories as well as question type were not found. The form for metadata was not user friendly.	Some categories were not found as there were not all categories arranged at the beginning but after requesting was included. Some question types were not found as these were not developed but were implemented during the course of the project. The form for adding metadata to the questions was improved and gave specific information which data is mandatory to be included.
<b>Were there problems while exporting questions from the database?</b>	Questions export basket not user friendly.	Most of the user thought that questions were immediately exported as they were added to the basket. Questions export basket usability was improved.
<b>Were there problems while searching questions through the database?</b>	Some search results were not displayed. Searching for creation date displayed only questions that were created on the specific date. Searching for author displayed no results.	Searching for creation date was improved by giving the opportunity to search a time period. Searching for author was extended by giving the opportunity to search the author based on his/her username, firstname or lastname.
<b>Is the design of the platform appealing?</b>	The design was evaluated as nice and modern but some improvements in the device accessibility were requested.	At the end there were enough design adaptations, in particular the mobile access.

#### 4. ADJUSTMENTS BEFORE PRODUCTIVE USE

For the transfer of the system into productive operation, specific adjustments were made and criteria were defined, especially in the second project phase. This chapter provides information on the three main adaptations of the design, the functionality and the question types and extensions. Of course, the data protection as well as the care and maintenance of the system for a secure regular operation of the platform should also be taken into account.

##### 4.1 Functional adjustments

After the first test phase, minor problems of the interface and user friendliness were improved, such as the direct, role-specific access to the questionnaire, the improved entry of mandatory metadata and the basket selected question export. The plugin for the search for metadata was improved and extended to include the search for metadata. After the second test phase, the design template in particular was adapted for better responsive design for mobile access to the QEP, e.g. a so-called hamburger menu was added and platform-specific links to project websites and to the question bank navigation were extended.

##### 4.2 Design and usability adjustments

The community provides a variety of other designs (so-called “themes”), some of which are free, others can be used and configured for free. In addition, personalized themes can be created and integrated, such as themes derived from Boost, so-called “child themes”. For this project the team uses the “moove” open-source theme plugin, which was further implemented to meet all the required functionalities and features, this project needed. The main changes were made in

order to improve the mobile access and scalability on different devices. Additionally, there were features which were disabled and new features were added to provide the users with better user interface and accessibility. For the purpose of better navigation functionality other open-source plugins were used and modified - “boostnavigation” and “static pages”. These were mainly used for the purpose of navigating through the website. Furthermore, at the beginning of this project the webpage showed around 30 quality errors which were checked and fixed with the help of the online WAVE Web Accessibility Evaluation Tool [15]. The mentioned fixes were created with the cooperation with employee of the TH Brandenburg and were decreased to only one error (see figure 7).



Figure 7. Design and usability adjustments test with WAVE tool.

### 4.3 Extension of question types and interfaces

After consultation with the project partners, the platform was expanded to include other question types that are specifically used at other universities, such as the All or Nothing Multiply Choice, a version of the central multiple-choice question with modified grading. In an All or Nothing Multiply Choice question, a respondent can select one or many answers. If the selected answers match exactly the correct answer choices defined in the question, the respondent receives 100%. If he/she chooses an incorrect answer or does not choose all the correct answers, the mark is 0% [16]. This question type is used specifically at the University of Potsdam. Furthermore, a question type STACK, an open-source system for computer-based assessments in mathematics and related disciplines with a focus on formative assessment, was added [17]. This question type is used especially at the FH Potsdam for assessments in the field of mathematics. In the project, a CAS Maxima server was set up for this purpose in the current version 5.44.0 and integrated into the QEP [18]. A training was also held with the project partners on the QEP to work with stack questions, and the FH Potsdam in particular loaded specific questions into the question bank. The BigBlueButton video conferencing system was integrated into the QEP specifically for video conferencing and used primarily for IT meetings and training, especially during the pandemic [14]. As a further interface, a video streaming server was used on which the video tutorials for training the project staff in the use of the platform were integrated [19].

## 5. SUMMARY AND OUTLOOK

In summary, it can be stated that with the QEP, a platform was created for the universities in the state of Brandenburg to make questions with metadata available across the universities. The platform was not only prepared for productive use, but it was also tested internally within the project to the extent that a transfer to regular operation would be possible. This, of course, requires financial resources that have to be available in order to keep the system running reliably, to carry out necessary updates and technical adjustments and, most importantly, to continually expand the question bank with categories and questions. Over the course of the two projects, the technical implementation was completed, where three test phases and two user trainings were carried out, the platform was continuously adapted, and the project staff was enabled to work on the platform. This concept can easily be transferred to regular operation if the necessary resources can be provided. Ultimately, after the three test phases, the adjustments made, and the role management as well as the available categories and questions, the system is ready to be transferred to productive operation, as long as the

financing for this is secured. All systems must run stably, administration and maintenance including updates must be ensured, and data protection and data security for hardware and operation must be ensured by a computer administration center of an external provider. The partner universities have indicated that this is necessary in particular a cross-university domain because the system should serve all universities of the State of Brandenburg. The next step would be to update the system with all components to the latest Moodle LTS version 4.1, since the current version 3.9. is still being provided with security patches, and if the framework conditions are fulfilled, then the already technically prepared productive operation could begin.

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## REFERENCES

- [1] oer-repo-ag.de, OER AG: Arbeitsgemeinschaft der OER-Repositorien und OER-Referatorien im Hochschulbereich, <<https://www.oer-repo-ag.de>> (1 November 2022).
- [2] smart.vhb.org, OER VHB: Repository für Online-Lerneinheiten der Virtuellen Hochschule Bayern, <<https://smart.vhb.org>> (2 November 2022).
- [3] twillo.de, OER Twillo: Portal für Open Educational Resources (OER), <<https://www.twillo.de/oer/web>> (2 November 2022).
- [4] moodle.org, Moodle Plugins: Edusharing, <[https://moodle.org/plugins/mod\\_edusharing](https://moodle.org/plugins/mod_edusharing)> (1 November 2022).
- [5] Kutzner T., Meißner M., Nesterow I., Rojas P., and Freytag A., "Concept of a cross-university question exchange platform with Moodle LMS", InnoEducaTIC 2020, 225-234 (2020).
- [6] prowichecks.de, QEP: Question Exchange Platform, <<https://www.prowichecks.de>> (12 October 2022).
- [7] moodle.org, Moodle Community: Moodle, <<https://moodle.org>> (10 October 2022).
- [8] questionmark.com, Questionmark Perception: Online Assessment Tool, <<https://www.questionmark.com>> (12 October 2022).
- [9] lplus.de, LPLUS: Professional eExamination Management, <<https://lplus.de/home>> (12 October 2022).
- [10] imsglobal.org, IMS: QTI specification, <<https://www.imsglobal.org/spec/qti/v3p0/oview>> (11 October 2022).
- [11] T. Kutzner, I. Nesterow, A. Freytag, "New Moodle plugin for IMS Question and Test Interoperability specification (QTI)", InnoEducaTIC 2021, 157-162 (2021).
- [12] moodle.org, Moodle Plugins: Questionfinder, <[https://moodle.org/plugins/local\\_questionfinder](https://moodle.org/plugins/local_questionfinder)> (12 October 2022).
- [13] bigbluebutton.org, BigBlueButton: Open-source web conferencing system, <<https://bigbluebutton.org>> (14 October 2022).
- [14] bbb.rzs.b-tu.de, BigBlueButton Server BTU: video conferencing system, <<https://bbb.rzs.b-tu.de/bigbluebutton>> (25 July 2022).
- [15] wave.org, WAVE: Web Accessibility Evaluation Tool, <<https://www.web.wave.org>> (13 October 2022).
- [16] moodle.org/plugins/qtype: multichoiceset, Moodle Community: Questiontype Multichoiceset, <[https://moodle.org/plugins/qtype\\_multichoiceset](https://moodle.org/plugins/qtype_multichoiceset)> (10 October 2022).
- [17] moodle.org/plugins/stack, Moodle Community: STACK questiontype, <[https://docs.moodle.org/39/de/Fragetyp\\_STACK](https://docs.moodle.org/39/de/Fragetyp_STACK)> (10 October 2022).
- [18] maxima server, STACK: CAS Maxima Server Version (Version 5.44.0), <<http://178.20.101.60:8081/maxima>> (13 October 2022).
- [19] streamingserver.rzs.b-tu.de, Video Streaming Server Kaltura BTU: video tutorials, <<https://streamingserver.rzs.b-tu.de/start/index.php>> (7 October 2022).