Extension of an online self-assessment Apps Portal for the use of selected Moodle e-assessments

T. Kutzner*[a], E. Kostova[b], A. Freytag[c]

[a]Dept. of Economics, Computer Science and Law, TH Wildau, 15745 Wildau, Hochschulring 1, Brandenburg, Germany; [b]AKTIF Technology Inc., Töpferstraße 9, 01968 Senftenberg, Germany, BTU Cottbus-Senftenberg, 01968 Senftenberg, Universitätsplatz 1, Brandenburg, Germany; [c]Institute of Medical Technology, BTU Cottbus-Senftenberg, 01968 Senftenberg, Universitätsplatz 1, Brandenburg, Germany

*tobias.kutzner@th-wildau.de; phone: +49 3375508609; www.th-wildau.de

ABSTRACT

In the rapidly evolving digitalization in education, learning management systems (LMS) have become an integral tool for educators. Leveraging this trend, this paper presents the evolution of a self-assessment application portal originally inspired by the didactic concept of a school mathematics app, which enables educators to effortlessly create interdisciplinary learning apps without having any programming knowledge. Building on this earlier work, this research explores the use of LMSs in different higher education institutions, with a particular focus on Moodle, and explores the question types and text editors used to apply them for self-assessment purposes. An important aspect of our research focuses on the seamless transfer of selected self-assessment questions from Moodle into the customised Apps Portal further developed in this academic work. The effectiveness of text editors as tools for the creation of self-assessment content is explored, with a particular focus on science, technology, engineering and mathematics (STEM). Finally, the results of the self-assessment application portal and its potential perspectives are presented.

Keywords: higher education, self-assessments, LMS Moodle, plugins, text editors, XML

1. INTRODUCTION

Based on the successful development of mathematics and physics apps for undergraduate studies at universities, the need for additional support for self-study has become apparent, especially with the increase in online learning due to the COVID 19 pandemic [1]. Furthermore, the global e-learning market is expected to grow at a compound annual rate of 17.54% between 2022 and 2030. The COVID-19 pandemic has accelerated the growth of e-learning, and many educational institutions and companies are now looking for innovative ways to offer online training [2]. Thus, the idea of creating a portal for the automatic generation of universal learning apps, that enable teachers to offer structured and controlled self-learning materials for different subjects, was born. After the initial development of the Apps Portal, an eBusiness application was created to serve as a test case for the portal's capabilities and functionalities. Due to the thorough testing of the app creation process and the resulting eBusiness app, new opportunities for optimization and improvement have emerged, driven by the invaluable feedback obtained from lecturers and students who participated in the testing of both the portal and the eBusiness app [1].

While the concept of a portal for creating self-learning tasks without programming knowledge is not entirely new, existing portals such as Quizlet, Kahoot or Quizizz allow for a wide use of user-generated content without strict verification of content accuracy. These portals are primarily used in the context of lectures and most of their content is only accessible via passwords or QR codes, which limits wider access [3][4][5]. In contrast, the approach of this work differs significantly: we offer compact, self-contained learning modules built according to a repetitive didactic model, taking inspiration from the successful model of the mathematics app at the Brandenburg Technical University (BTU) Cottbus-Senftenberg and applying it to different subject areas. The portal provides educators with a precise framework, limits the scope of the tasks to obtain manageable learning units and, on the other hand, at the same time enables students to delve deeper into a specific topic.LMSs such as Moodle, Blackboard or Canvas are becoming increasingly popular in educational institutions as they provide a central portal for managing, organising and delivering course materials. One of the most important features of

Moodle is the ability to create quizzes that can be used for student assessment [6]. However, the challenge is to find an effective way to use them to enhance the student learning experience. For this reason, the integration of existing Moodle assessments was one of the main goals in optimising the Apps Portal. In this way, the range of pedagogical self-assessment materials will be expanded, and teachers and learners will have access to a wider range of quality content for enriching learning experiences. The tasks do not have to be created from scratch but can be used both in the LMS and in the Apps Portal as a reassembled assessment, saving work and time and making additional material available to students for in-depth learning.

2. CROSS-UNIVERSITY SURVEY ON THE EVALUATION SYSTEM

At the inception of this scientific undertaking, questionnaires were distributed among two German universities to gather essential information for shaping the development of the Apps Portal. These questionnaires focused on aspects such as university preferences for LMS, the use of additional systems for examinations, and the degree of dissemination of specific question types. Furthermore, inquiries were conducted to discover the prevalent text editors used by these institutions, particularly in the context of the future creation of applications with mathematical notations. The knowledge and insights acquired through these surveys laid the groundwork for ongoing improvements and enhancements to the Apps Portal. By leveraging the information gathered, we gained a clearer understanding of how to create the algorithm, that should enable the efficient migration of the frequently used questions while harnessing the benefits of the previously developed method for creating self-assessments applications, which will be mentioned in the next chapter. The following table summarizes the evaluation of the survey among the selected universities on the use of questions in the various learning management and e-examination systems (see Table 1).

Table 1. Research results among the universities

Universities	BTU Cottbus-Senftenberg	TH Wildau
Questions	Answers	Answers
1. Moodle version	Version 4.1	Version 4.1
2. Which system(s) do you mainly use for digital exams at your university and currently in which version?	Moodle LPLUS	Moodle Questionmark Perception
3. Which question types are most commonly used in your LMS or exam system(s)?	Short answer Multiple-choice and true or false Numerical Cloze	Numerical Multianswer and multiple-choice True or false Short answer
4. How many questions (of the most commonly used question types) are currently available in your systems?	Sort answer 89696 Multiple-choice and true or false 79012 Numerical 41983 Cloze 22128	Numerical 965223 Multianswer and multiple-choice 193558 True or false 11673 Short answer 9804

Universities	BTU Cottbus-Senftenberg	TH Wildau
Questions	**Answers**	**Answers**
5. What exchange format, in what version, does your LMS or exam system use to store or transfer questions from one system to the other? (e.g. QTI version 1.2)	LPX (LPLUS) XLS (Moodle) XML (Moodle) Blackboard (Moodle) GIFT-Format (Moodle)	QML (Questionmark Perception) XML (Moodle) Aiken (Moodle) GIFT-Format (Moodle)
6. Are additional tools used for this purpose? (e.g., to customize formats) If yes, which ones?	No	No
7. Total number of questions in the Moodle database.	263957	1198853
8. Which is the standard text editor that is used in the Moodle LMS?	Atto Text Editor	TinyMCE Text Editor

For the survey, two queries in Structured Query Language (SQL) were sent to the e-learning platform's administrator at each university to ascertain the precise number of questions. The first SQL database query was formulated as follows: "SELECT qtype, Count() as number_questions FROM mdl_question GROUP BY qtype ORDER BY number_questions DESC;". The query was used to categorise and count the questions by type. To determine the total number of questions in the database, a second SQL database query was formulated: "SELECT Count() as number_questions FROM mdl_question;".In late May, both BTU Cottbus-Senftenberg and Technische Hochschule (TH) Wildau responded to our questions, but the answers were not specific enough. While it was evident which question types were most commonly used, the specific order of these questions was not provided in their responses. Afterwards, at the end of August, the participants utilized the recommended SQL inquiries to provide more accurate data for statistical analysis. To evaluate the table, it is important to note that the large numbers shown in the table may be inflated due to the duplication of Moodle courses, the associated data and the obstacle to filter the question bank obtain only the unique questions. Therefore, the number of individual questions is likely to be lower than the numbers shown.

The results show that the most frequently used Moodle question types are Short Answer, Multiple Choice, True/False, Numerical and Cloze. Accordingly, after evaluating the survey, it was decided to focus on these question types first and implement the conversion algorithm for them. This currently offers the advantage whereby a large number of questions of these types can be imported from Moodle to generate new assessments-apps for different task areas with the help of the Apps Portal. Moreover, this would enable users not only to import but also to export assessments, by downloading the applications' tasks in Moodle XML format. This means that these created assessments can be distributed and utilized at other universities using Moodle as their LMS. Based on the evaluation and the growing number of different assessment questions in the universities' databases, the extension of the portal appears to be very valuable. Investigating the standard text editors used by the participating universities was also an essential aspect of our survey. Finally, the question about text editors resulted in BTU Cottbus-Senftenberg using the Moodle text editor Atto with integrated LATEX functions for mathematical notation. Meanwhile, TH Wildau is using the TinyMCE text editor with the MathML functions of the integrated MathType keyboard for mathematical notation.

3. CONCEPT AND IMPLEMENTATION

This chapter introduces the foundational concept of the portal, which comprises two integral components. The first part encompasses the didactic concept of the app, serving as the fundamental template for all subsequently generated apps. Drawing inspiration from established principles, this didactic concept is designed to provide an effective and engaging learning experience. The second part of the concept refers to the portal itself, where these apps are created and subsequently published.

3.1 Concept of the didactic apps and the Apps Portal

The didactic concept that underpins the entire Apps Portal and serves as the template for all generated applications draws heavily from the principles of programmed learning according to Skinner in 1958. This concept emphasizes individual pace, clear learning objectives, immediate feedback, and task design with a high probability of correct solutions [7].

Each generated app is structured into three essential sections, contributing to an effective learning experience. The introduction page offers users clear instructions on task-solving strategies, ensuring preparedness. The task section is the central component, where users input their time, evaluate task difficulty, indicate answer correctness, both based on their own feeling, and access helpful resources. This section empowers users to overcome challenges and deepen their understanding. Finally, the statistics page presents visual data, including completion times, user perceptions of task difficulty, and answer correctness, providing valuable insights into user progress and achievements within the app.

The portal includes a login page that allows users to create accounts using an email and password, serving as the entry point for portal usage in terms of creating new assessments. A central feature is the homepage, where all generated applications are listed for easy access, enhancing navigation. Registered users can utilize the app generation pages and create new applications, with images, Moodle XML question files and mathematical notations, as well as to choose between different types of questions such as multiple-choice, true or false and short answer questions.

3.2 Feature enhancement of the Apps Portal

Since the initial development of the Apps Portal, numerous opportunities for optimization have been identified. Originally, the portal only supported the basic task of image uploads. However, as part of its evolution, two key enhancements were implemented.

Firstly, the portal now incorporates the functionality to import Moodle XMLs directly. This upgrade enables the efficient generation of assessment applications, thereby saving significant time that would otherwise be spent creating new content from scratch. The inspiration for this feature was derived from a previously developed Moodle plugin designed for questions transfer from Questionmark Perception (QMP) to Moodle LMS. This involved the conversion of QTI 1.2 into Moodle XML format, providing valuable insights for the development of this feature [8].

Secondly, an integrated text editor, TinyMCE with MathType, was launched. This addition provides users with a versatile tool to create applications. Users can now seamlessly include images, incorporate complex mathematical notations, and format their text content according to their requirements. This comprehensive feature set enhances the portal's utility and user-friendliness for content creators and educators alike.

Moreover, the integration of new question types, such as multiple-choice, true or false, and short answer questions, has significantly improved the assessment capabilities of the applications. This addition has introduced a fresh approach to evaluation, consequently enhancing the overall learning experience for learners.

3.3 Functionality for Moodle XML question import

In the logic of this new feature, which allows the import of Moodle XML questions, lays a converter algorithm, that is gathering data from the Moodle XML and maps it in the standard XML, which the Apps Portal is using to display its assessments-applications. The data, which is transferred includes information such as the question itself, its answers, their fraction percent, feedback for incorrect answer and all the media, e.g. images, that was created with the respective Moodle question.

3.4 Functionality for text input with editor

The applications portal has been enriched with a valuable feature, allowing users to generate self-assessments effortlessly through the utilization of the TinyMCE WYSIWYG (What You See Is What You Get) rich text editor. To further enhance its functionality, a MathType keyboard has been integrated. This newfound capability empowers users to construct complex mathematical formulas, expressions, and related content, thereby broadening the spectrum of STEM features available within the portal [9].
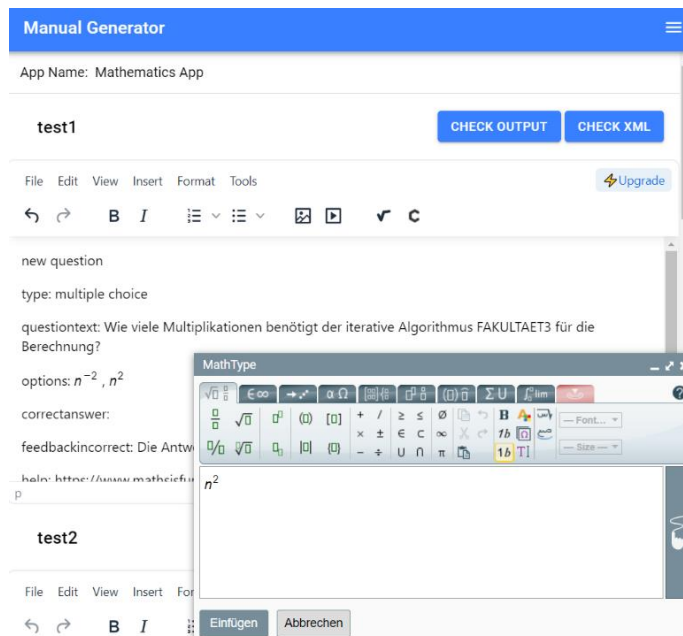
Figure 1. Creation of self-assessment-application with text editor

Users can access the portal to either create assessment apps or solve them. The newly added features allow users to create apps by uploading Moodle XML questions or by typing them manually using the built-in TinyMCE text editors. The Moodle XML questions upload requires users to export five separate files (in Moodle XML format), each containing five questions. The acceptable question types are multiple choice, true/false, or short answer. When using the TinyMCE text editor, it is recommended to use the portal's schema, attached to the corner of the page. When creating, users must also provide an app name and image, and can optionally include help links for each question to enhance student learning and comprehension. The completed apps are added to the pool with all the applications (see Figure 2).
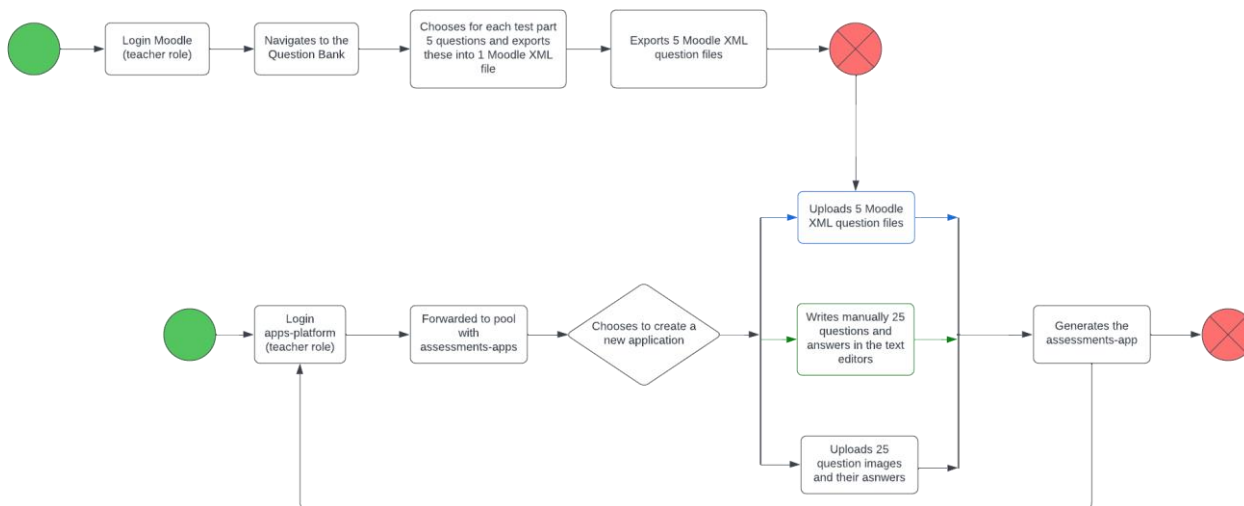
Figure 2. Concept for the creation of self-assessments-applications

4. TEST

The upcoming section provides a test case that demonstrates the process of generating self-assessment applications using our app creation page and incorporating Moodle XML questions. In order to create an application using Moodle XML, educators must prepare twenty-five quiz questions in Moodle XML format. These questions need to be divided into five distinct evaluation segments, referred to as "tests" or "pools", each containing precisely five questions. The accepted question types are limited to multiple choice, true or false, or short answer questions. The user should export these questions from Moodle as five separate XML files. Next, they must log in to the Apps Portal using their registration credentials (email and password). Within the portal's Moodle XML creation page, the user should specify a name for the forthcoming application and proceed to import all five XML files. The final step involves confirming the creation, resulting in the generation of the application. For a more user-friendly and simplified approach, we used a custom Moodle plugin that had been internally developed as part of the cross-university project "StudiPortal Brandenburg" [10]. This plugin empowers users to effortlessly export specific questions, which can then be organized within what we refer to as the "export shopping cart" for added convenience and usability, as shown in the images below.
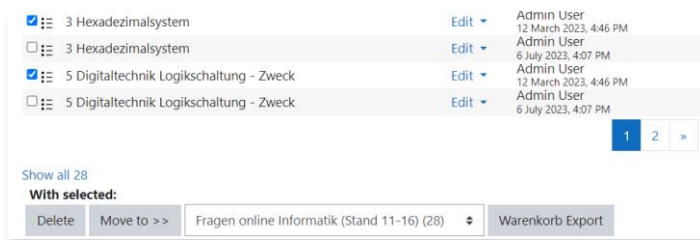

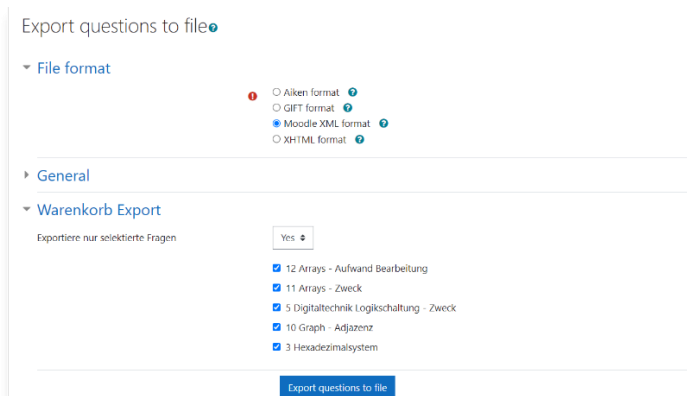Figure 3. Selection of certain questions

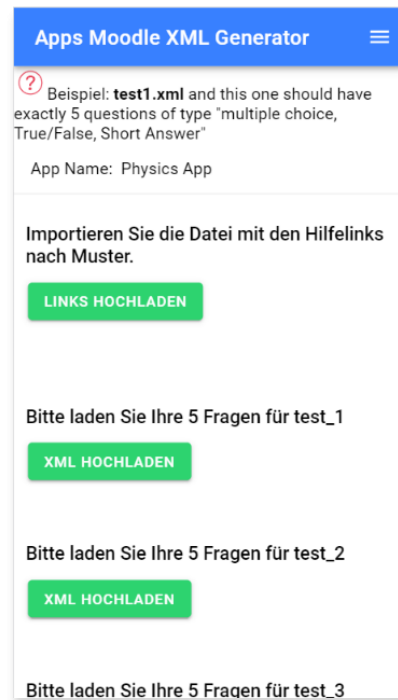Figure 4. Import of Moodle XMLs into the Apps Portal

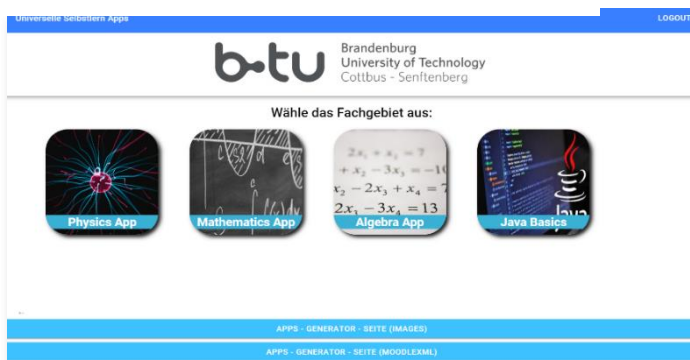Figure 5. Export of 5 questions for one of the evaluation parts

Figure 6. Overview of the created applications

5. SUMMARY AND OUTLOOK

We have successfully implemented and tested the import feature for Moodle XML questions, specifically for the question types such as multiple choice, true or false, and short answer questions. This enhancement provides two additional methods for importing questions into our portal, aside from creating applications solely with images. The first method involves importing Moodle XML questions, while the second allows the direct creation of questions within the Apps Portal using the integrated TinyMCE text editor. When creating questions, users have access to all the functionalities of the WYSIWYG editor, including support for mathematical expressions and formatting. These apps can be seamlessly published as HTML5 web apps on our website, creating new opportunities for the creation and distribution of educational content.

These advancements significantly bolster the portal's capabilities, enabling educators and learners to develop self-assessment applications with greater flexibility and depth. Consequently, our portal can become an invaluable resource for educational institutions.

Regarding future plans, several exciting opportunities are on the horizon. Firstly, we plan to expand the variety of question types available and improve the export functionality for questions from our Apps Portal into other LMSs and examination systems. This will make it easier for educators to integrate our content into their preferred systems and provide a smoother educational experience. Additionally, the development of a feature that would enable the generation of Moodle assessments directly from existing applications is considered. This would streamline the process of sharing and utilizing educational content.

6. ACKNOWLEDGEMENT

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