

PAPER

Enhancing Online Assessment Quality in Higher Education: The Design of Moodle Plug-in for Personalised Exam Revision (PER)

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ABSTRACT

The diversity of learner profiles in online environments underlines more than ever the importance of a personalised approach to effectively addressing assessment and revision needs for exams to ensure better adaptation to individual needs, enhance the learning experience and maximise learners' chances of success. MOODLE (modular object-oriented dynamic learning environment), a leading learning management platform (LMS), supports a number of activities for the assessment of learning. Unfortunately, there is currently no module designed for personalised revision. The personalised exam revision (PER) plug-in for MOODLE is intended to enhance the personalisation of revision for examinations. This work explores the process of designing and developing an adaptive plug-in for MOODLE, designed to enhance the personalisation of learning paths. Based on the ADDIE (analysis, design, development, implementation, and evaluation) methodology, this study begins with an analysis of the needs of the main users, putting the learner at the centre of interest. This study identified opportunities for integration and optimisation, highlighted current strengths and weaknesses, and reinforced our positioning concerning the literature and the revision path outlined in our specification. By combining a proven methodology with a learner-centred approach, the ultimate goal is to offer learners and teachers a complete, powerful assistant for enriching, personalising and monitoring online revision.

KEYWORDS

online environments, assessment, revision, modular object-oriented dynamic learning environment (MOODLE), plug-in personalised exam revision (PER), analysis, design, development, implementation, and evaluation (ADDIE)

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1 INTRODUCTION

In the era of online assessment, adapting revision to individual needs has become crucial to improving pedagogical effectiveness and student engagement. In our previous research, we conducted a comparative study of online assessment platforms to define which is the most appropriate platform for adaptive revision [1]. This led us to choose modular object-oriented dynamic learning environment (MOODLE) for the development of our adaptive revision plug-in. This decision was reinforced by the results of an exhaustive questionnaire which assessed the experiences and obstacles encountered by students when using MOODLE's current tools during a hybrid course (87% of students reported having encountered technical problems when taking exams on MOODLE and expressed a preference for simplified revision and assessment materials), as well as determining their preferences and expectations in terms of adaptive revision. On this basis, we decided to develop an adaptive revision plug-in for MOODLE, aimed at personalising the revision path according to students' individual performance.

The paper will be divided into four sections: The first part constitutes a positioning of our authentic approach, which has never been addressed in existing work. The analysis, design, development, implementation, and evaluation (ADDIE) methodology focuses on the analysis and identification of needs (functional and technical requirements) as well as the integration of adaptive revision logic aligned with the specific needs and learning pace of each student. The Design section describes the Agile design of the plug-in, its workflow and the various development phases, while the Future Work section presents the prospects for development and the challenges ahead.

By detailing the modular architecture of our solution, we aim to provide a roadmap for the development of adaptive and personalised revision functionalities within MOODLE, thus contributing to the advancement of personalised digital education.

2 MOTIVATION

2.1 The psycho-pedagogical foundations of the effectiveness of adaptive revision plug-ins

Revision is an essential element of the learning process, allowing not only to refresh knowledge but also to integrate it durably into long-term memory. The importance of this step is highlighted by various contemporary studies, starting with the Cognitive Load Theory (CLT) developed by John Sweller, which emphasises the importance of managing learners' mental load during revision to optimise learning [2]. He insists on the necessity of managing mental load to avoid cognitive overload and improve retention. As for Rowland, the active retrieval of information plays a central role in strengthening memory, making the information more resistant to forgetting [3]. In a similar perspective, Toppino and Cohen found that spaced reviews, known as distributed practice, are a technique that leads to better information retention compared to massed study sessions [4]. Finally, Smith and Karpicke highlighted that combining spaced reviews with active recall techniques improves memorisation by strengthening neural connections [5]. Thus, revision proves to be essential not only for strengthening memory but also for establishing a solid foundation for the future application of knowledge in different contexts.

Adaptive revision plug-ins derive their effectiveness from two essential psycho-pedagogical principles: 1) spaced repetition and 2) the forgetting curve.

- **Spaced Repetition:** This principle, well established in the study literature on learning, supports that information is better retained if learning sessions are spaced out over time rather than grouped into a single session [6]. In the context of adaptive review plug-ins, algorithms are used to determine the optimal interval between review sessions for each learner, taking into account factors such as the user's previous performance and the time available for study.
- **The forgetting curve:** Introduced by the psychologist Hermann Ebbinghaus, this concept describes how information is lost from our memory at a decreasing rate [7]. Adaptive review plug-ins use this curve to predict when a user is likely to forget information, thus effectively planning a review session.

By combining these two principles, adaptive revision plug-ins provide a personalised learning path for each learner, which can also double the effectiveness of knowledge retention compared to traditional methods, increasing the chances of long-term information retention and academic success.

2.2 Challenges of adaptive revision

Adaptive revision, which aims to dynamically adjust learning content and strategies to the specific needs of users, still faces several challenges in current systems [8]. Firstly, the lack of real-time personalisation limits their ability to adapt to rapid variations in learner behaviour and performance [9]. In addition, learner data management remains complex, with current solutions struggling to effectively collect, analyse and interpret massive learner interactions [10]. Learner engagement is also a major challenge, as existing approaches rarely incorporate sufficiently interactive and motivating elements to maintain interest over the long term [11]. Furthermore, these systems often lack interoperability and scalability, making it difficult to integrate them with other educational platforms or adapt them to technological advances. Finally, algorithmic biases represent a persistent problem, with often biased data negatively influencing adaptive recommendations, compromising their fairness and effectiveness.

2.3 Scope study: Positioning and contributions

Existing work focuses primarily on distance learning platforms, exams, assessments, or learner satisfaction with the platforms, but little or none on online revision as an essential stage of learning that is often overlooked but conditions learner success. On the other hand, MOODLE with its open-source nature, is an essential reference among learning management systems (LMS), offering digital course makers remarkable freedom to design, customise and integrate new features [12]. With its robust structure, MOODLE is perfectly positioned to incorporate such plug-ins, and its growing popularity in the academic era ensures that innovations introduced via plug-ins find a receptive and engaged audience [13]. This observation, combined with the conclusions of our first comparative study of distance assessment platforms, justifies the choice of developing PER plug-ins for MOODLE. Table 1 shows that no current study has explored online adaptive revision, leaving a gap that this

work aims to fill in a dual way: by responding to a current pedagogical problem and by proposing a viable and scalable technical solution.

Table 1. Positioning and gaps in existing works

Reference	Objective and Issues	Main Results	Positioning and Added Value of Our Work Based on Existing Solutions
Huerta-Gomez-Merodio et al. (2024) [14]	Study the impact of personalisation tools (FastTest) on the user experience and the effectiveness of evaluations.	Automation and personalisation tools increase user engagement and enable questions to be adapted to the level of the learner.	The authors propose an applicable automation model for personalising review paths. Limited to a specific tool (FastTest) and static customisation, with no continuous adaptation mechanism.
Sireci, Stephen G., et al. (2024) [15]	This article aims to improve adaptive assessment by proposing a more effective and accurate method of measuring learners' skills.	Development and validation of a new methodological framework for adaptive evaluation.	Integration of new techniques (machine learning, probabilistic modelling, etc.) to improve test adaptation in real time.
Manousou & Rassia (2024) [16]	Explore innovations in online assessment, such as portfolios and open-book exams.	Innovative assessments allow for individualised learning paths but require in-depth ethical and technical reflection.	Introduces flexible assessment approaches that can be integrated into an adaptive platform. Does not cover real-time personalised revision or the use of data to adapt content.
Mwangi, Imonje & Kalai (2023) [17]	Assess student satisfaction with Moodle's online assessment features.	Students appreciate the quizzes (85%) and the confidentiality of marks (85%) but are dissatisfied with the reports generated (66%). Anxiety and cheating remain problematic.	Emphasises the importance of immediate feedback and reducing anxiety. However, it does not address the dynamic adaptation of content to individual performance.
Cross et al. (2023) [18]	Study the impact of online exams on students' experience before and after the pandemic.	Online exams reduce anxiety but can be perceived as more difficult. Assessments need to be tailored to the level of the learner.	Stresses the importance of designing appropriate assessments to reduce learner stress. Focuses on exams, without exploring the personalisation of revision paths during exam preparations.
Ferreira-Meyers (2022) [19]	Analyse the impact of digital tools on personalising learning paths.	Personalised and frequent interaction increases learner engagement but requires intuitive tools.	Underlines the importance of personalised interaction in adaptive systems. However, it does not propose automated mechanisms for adapting revision content according to performance.

3 METHODOLOGY

This work will put in place a methodological structure based on the ADDIE method. Despite the existence of several educational conception models, such as the SAM model or the Dick and Carey model, the ADDIE method has been chosen for its iterative and adaptive approach. This tried-and-tested method guides the creation and development of educational projects [20]. Figure 1 shows that the first three phases of the ADDIE method, namely Analysis, Design and the first orientations concerning Development, will be covered in this work (green), while the Implementation and Evaluation phases will be addressed in a future study (orange).

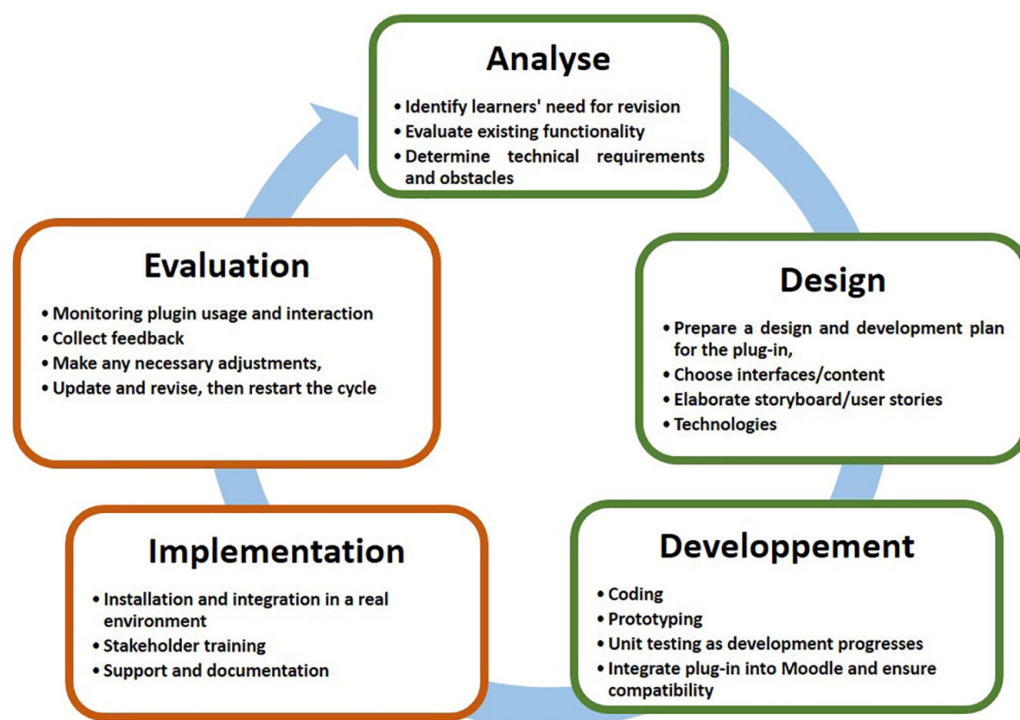


Fig. 1. ADDIE model application

4 ANALYSIS AND IDENTIFICATION OF REQUIREMENTS

Various readings have enabled us to identify the needs expected by teaching teams and learners in terms of adaptive revision [21] [22]. Reinforced by a survey of learners' preferences and needs in terms of online assessment at the Chouaib Doukkali University, where the overwhelming majority of students (86.7%) showed an interest in revision sessions on the MOODLE platform. As for the preferred frequency of these sessions, opinions varied: 29.1% of participants preferred sessions after each course session, while 27.7% wanted revision just before exams.

The idea would therefore be to design and implement an adaptive revision plug-in that would enable registered students to revise their courses, practise and take tests at their own pace, remotely and completely online, to prepare well for the final exam.

This specification describes the functional and technical requirements for the development of a personalised revision plug-in for the MOODLE platform.

Objectives:

- To create a revision interface adapted to the individual needs of each learner.
- To enable teachers to monitor their students' progress.

Like any educational project, it must meet the quality-cost-time triangle. To achieve this, a defined specification must take into account the following requirements and milestones as illustrated in Figures 2 and 3.

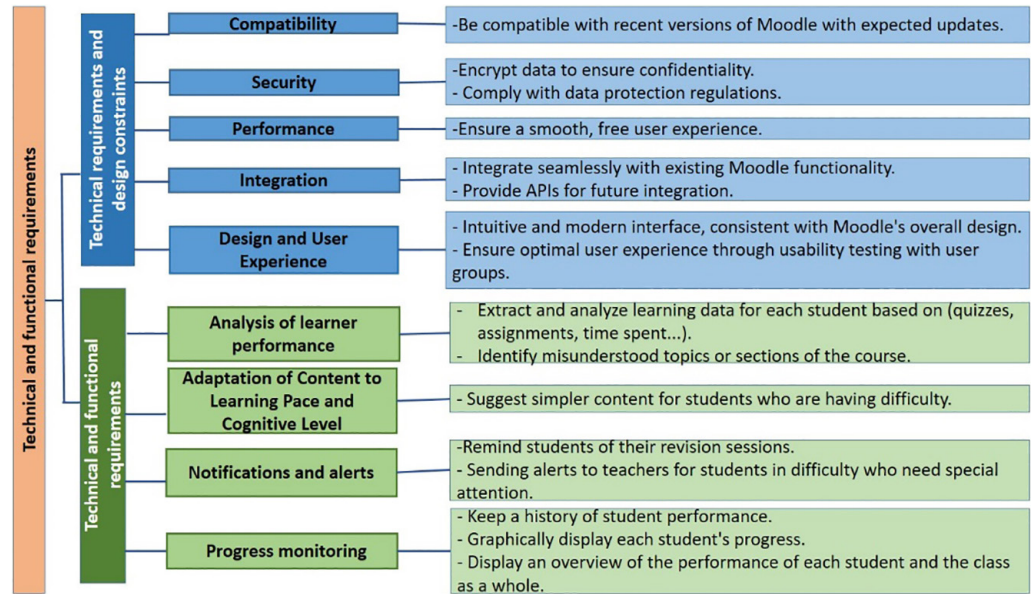


Fig. 2. PER functional and technical specifications

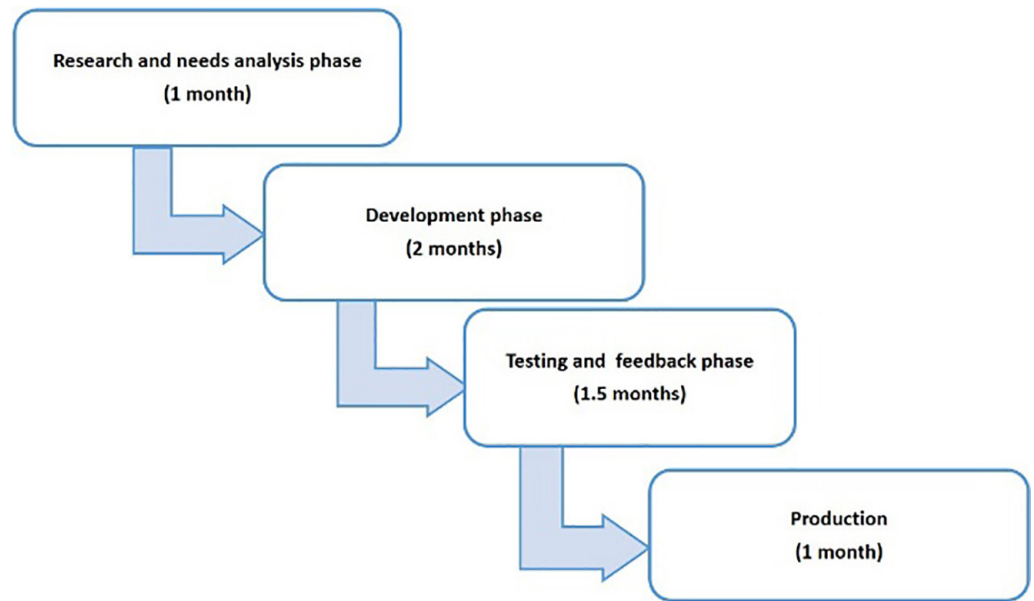


Fig. 3. Project milestones

4.1 Technologies underlying MOODLE’s adaptive revision plug-ins

The technologies supporting MOODLE’s adaptive revision plug-ins are both diverse and interconnected, providing a synergy that aims to enhance the learning experience. At the heart of these plug-ins are adaptive learning algorithms, which draw on the user’s previous interactions to modulate content and exercises in real time [23]. These algorithms are often supported by artificial intelligence (AI) and machine learning (ML) technologies, enabling further personalisation and prediction of learning needs [24] [25]. The management of the massive data generated is facilitated by robust and scalable database management systems (DBMS) [26]. The principles

of spaced repetition learning are also integrated, drawing on research in cognitive psychology to optimise memorisation. For fluid interactivity, web technologies such as PHP, JavaScript and AJAX are used while incorporating UX/UI designs for improved ergonomics [27]. In addition, API integration facilitates collaboration between Moodle and other platforms or educational tools, amplifying the resources available. Finally, as the demand for accessibility increases, assistive technologies are integrated to ensure that all students, regardless of ability, can benefit equally from the plug-ins [28].

5 DESIGN: AGILE DESIGN FOR PLUG-IN FUNCTIONALITY DEFINITION

5.1 Plug-in end-user workflow summary

This plug-in is designed to facilitate adaptive learning and mastery of course content through a systematic workflow. Here's a realistic scenario to illustrate how it works, as illustrated in Figure 4:

- **Mock Exam Initialisation:** Students start by taking a mock exam that evaluates their knowledge across each chapter.
 - Outcome:**
 - If the score is $\geq 90\%$, students proceed to the next chapter.
 - If the score is $< 90\%$, the plug-in identifies weakness in that chapter for focused improvement at the end of the quiz results and on a separate page.
- **Gap Identification and Revision Plan:** The plug-in analyses and suggests improvement on a separate page to address knowledge gaps.
 - It generates a **personalised revision plan** that includes:
 - Chapter-specific quizzes.
 - Relevant study materials tailored to address the gaps.
- **Quiz Attempts for Targeted Improvement:** Students take chapter-specific simplified quizzes focusing on areas of improvement with up to **3 attempts** per chapter.
 - **Pass ($\geq 90\%$ with 3 attempts allowed):** Progress to the next chapter.
 - **Fail (after 3 attempts):**
 - The plug-in provides simplified learning materials on a separate page.
 - The process repeats until the students achieve a 90% threshold on retake quizzes.
- **Reassess Through Mock Exam:** Once the student completes the targeted revisions, they retake the mock exam to evaluate overall readiness.
 - Outcome:**
 - **Pass ($\geq 90\%$):** Move on to the next chapter.
 - **Fail ($< 90\%$):** The system loops back to revision for the chapter with gaps.
- **Continuous Progression Through Chapters:** The cycle of mock exams, personalised revision, and targeted quizzes continues until students achieve mastery in all chapters.
- **Professor Alerts for Persistent Gaps:** If students fail to improve despite simplified materials and additional attempts, the plug-in notifies the professor for further intervention.

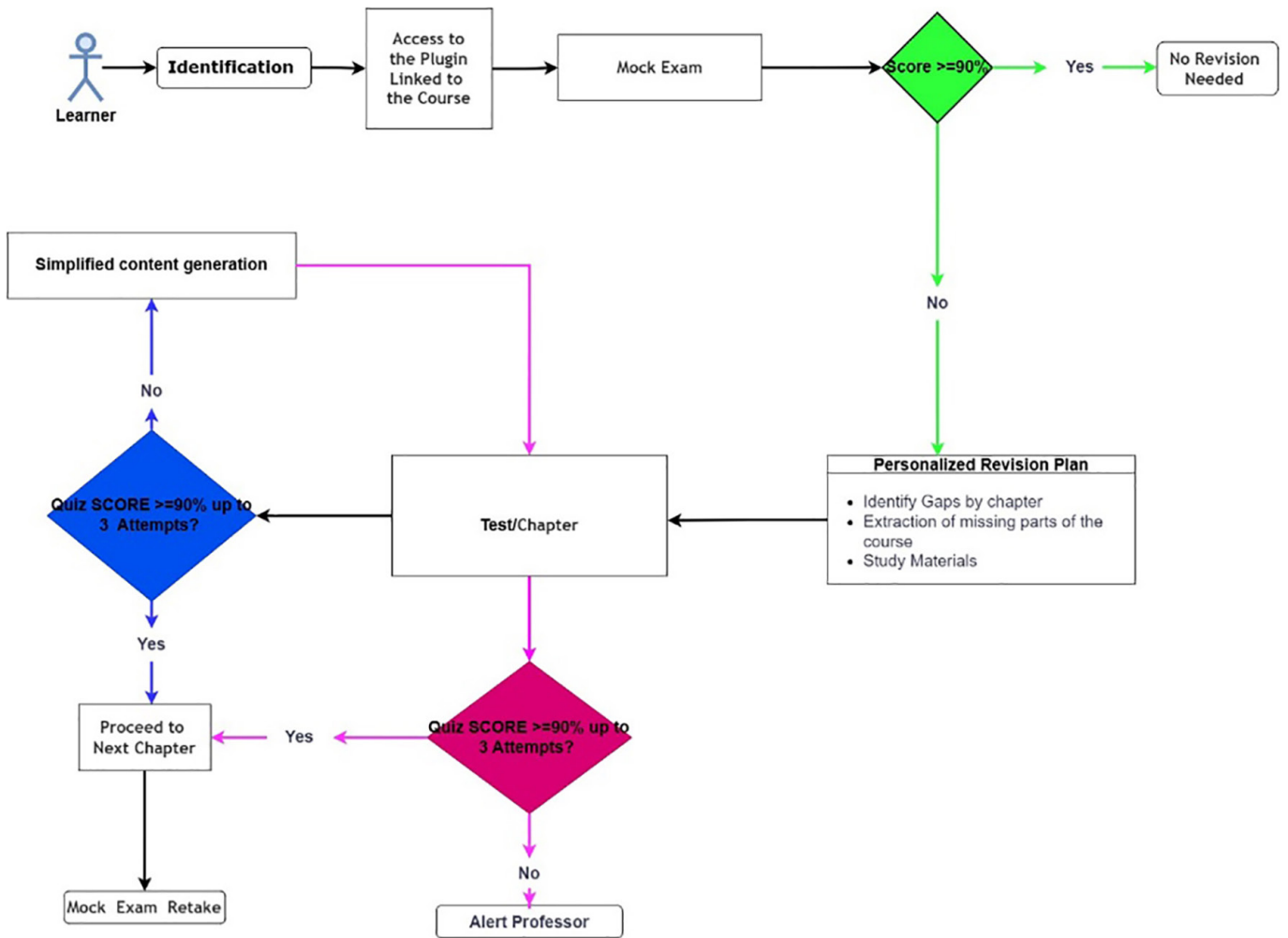


Fig. 4. Plug-in flow chart

The design of this application model requires a tight weave between assessment teaching practices and educational engineering. As this PER's design phase is the most important stage in the development of this PER Plug-in, we opted for the UML (unified modelling language) to represent the various structures and interactions as simply as possible [29]. The three UML diagrams in Figures 5–7 illustrate, respectively, the use case diagram that shows the relationships between the main actors and functionalities, then the class diagram which describes the main software entities and their interactions, and the sequence diagram that maps the chronological sequence of interactions.

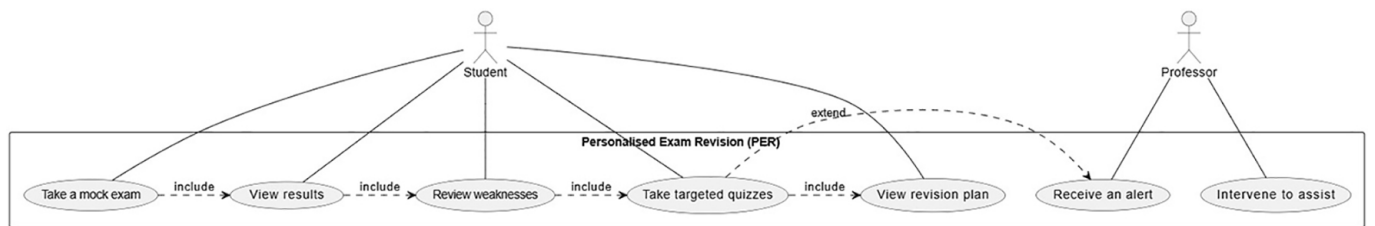


Fig. 5. Diagram of use

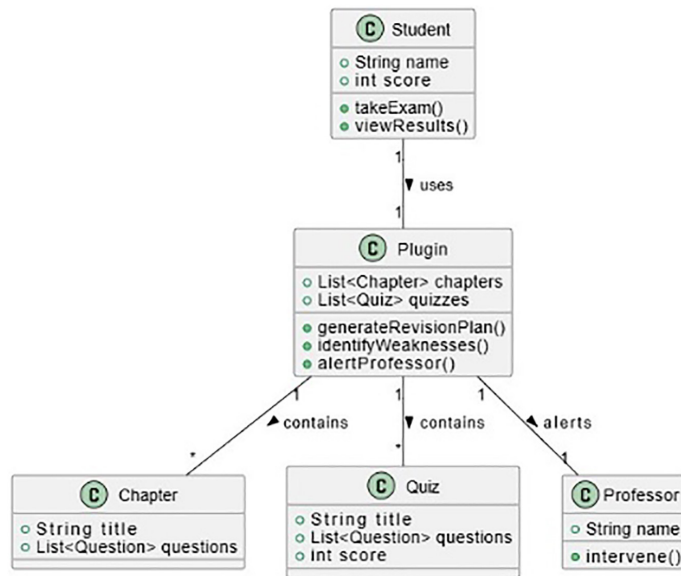


Fig. 6. Class diagram: Plug-in structure

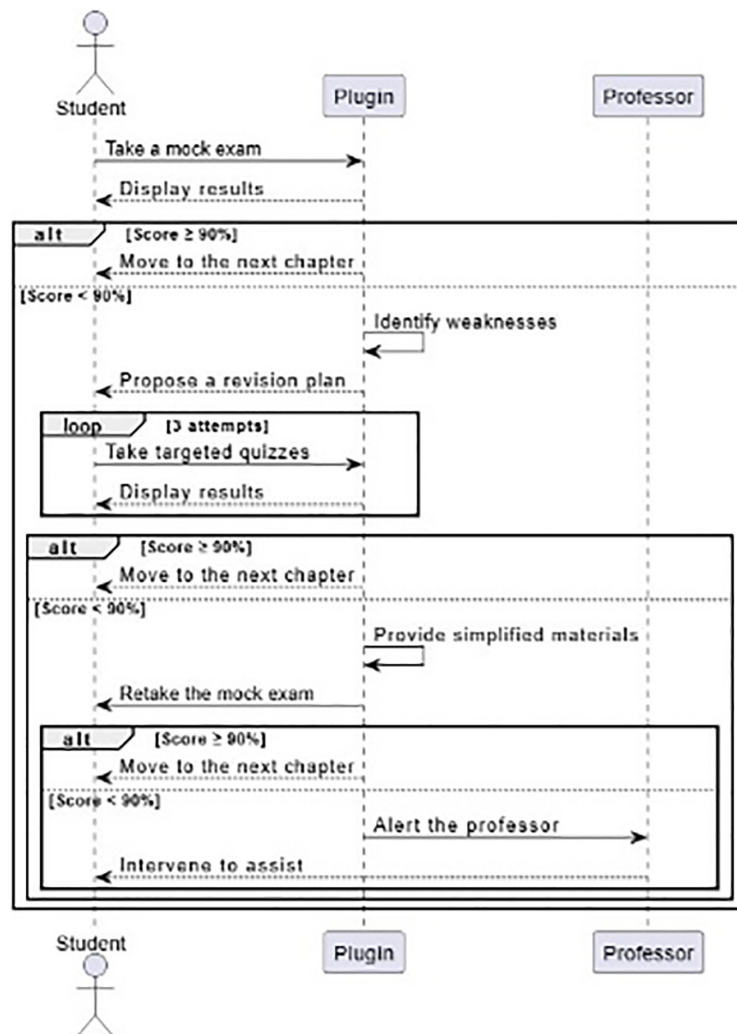


Fig. 7. Sequence diagram: Interaction between plug-in and MOODLE database

6 DEVELOPMENT: PRELIMINARY GUIDELINES

6.1 Preparatory phase: Setting up the test environment

Before embarking on the in-depth design of the adaptive revision plug-in, it was essential to fully understand the capabilities and constraints of the environment in which it would be integrated. Once MOODLE was installed, we felt it crucial to simulate a realistic learning environment. This led us to populate MOODLE with dummy courses, covering a variety of subjects and formats. These courses were designed to reflect the full spectrum of content types and activities that might be found in a real educational environment. In addition to the courses, the creation of dummy user profiles (10,000 users) was equally essential. These “dummy users” were added to our MOODLE test environment to simulate different roles, such as students, teachers and administrators. This allowed us to test how different users would interact with the plug-ins and get a complete view of the user experience.

6.2 Analysis and evaluation phase of existing MOODLE plug-ins for adaptive revision

In order to effectively guide the design and development of our own solution, we explored and tested several adaptive revision plug-ins available on MOODLE. The aim of this approach was to assess their strengths and weaknesses in order to take advantage of their functionalities. Table 2 is a selection of the main MOODLE plug-ins, their advantages and limitations in relation to their use in adaptive revision:

Table 2. Test and analysis of existing plug-ins

Plug-ins	Description and Advantages	Limits
Compilation Progress	Monitors and compiles the student's adaptive learning progress, enabling clear visualisation of progress and real-time notifications.	<ul style="list-style-type: none"> – Requires initial configuration. – Can be cumbersome for some MOODLE installations.
Adaptive Quiz	Offers flexibility in quiz design by adjusting the difficulty of questions based on students' previous answers.	Can be more difficult to configure than other options.
Student Quiz	Allows students to contribute to the question bank and create their own quizzes for review, peer assessment, tracking student progress, and promoting collaborative learning.	Need for moderation to ensure quality questions.
Personalised Learning Designer (PLD)	Create personalised lesson plans for learners while automating actions based on defined events, such as sending a message after a failed quiz.	May require extensive planning and configuration.
Level Up!	Integrating gamification Allows students to “level up” through “earning badges” based on their commitment and achievements, is customisable and guarantees compatibility with other plug-ins.	Requires adaptation time for teachers and students unfamiliar with gamified systems.
Moodle Flashcard	Create flashcard games to help students revise and memorise content, which can be customised for each student.	Can be limited in terms of the types of content that can be reviewed.
Learning Analytics	Offers predictions of student engagement and academic performance based on pre-trained models. Recommends further revision to enable proactive interventions.	If students don't regularly work on the MOODLE platform, predictions may not be accurate.
H5P Interactive Content	Easy to use Allows you to create, share and reuse a variety of types of rich interactive content. This can range from interactive videos to quizzes that adapt to student responses.	May require training for those new to content creation.

(Continued)

Table 2. Test and analysis of existing plug-ins (Continued)

Plug-ins	Description and Advantages	Limits
Configurable Reports	Allows users to create reports based on their specific needs, which can be exported in various formats such as Excel or PDF.	It takes a while to figure out how to configure the reports the way you want them.
My Learning Path	Allows students to concentrate on subjects they are less familiar with, maximising the effectiveness of their revision.	For instructors, analysing progress and manually adjusting courses can become time-consuming, especially for large groups of learners.

Initially, we had the idea of using or combining them, but after careful consideration, we’re now convinced that it’s better to start development from scratch in order to meet our needs precisely and avoid the limitations imposed by existing solutions.

6.3 Phase 2: Module development and integration

This phase focuses on the actual development and initial testing of the plug-in’s core functionalities.

- Mock Exam Module: Implement the mock exam feature, adhering to the requirements to support assessments and identify knowledge gaps.
- Revision Plan Module: Develop a personalised revision plan generator based on identified gaps, integrating relevant learning resources.
- Quiz Attempt Module: Build a dynamic quiz system with configurable attempts, grading criteria, and simplified support for retry mechanisms.
- Data Storage Module: Create a robust data storage layer to securely manage all plug-in-related records.
- Thorough Testing: Each module undergoes extensive functionality and integration testing to ensure smooth operations.
- Codebase Integration: Consolidate all modules into a single synchronised repository, ensuring inter-modular communication and compliance with requirements.

The diagram in Figure 8 demonstrates the interactions between system modules and dependencies.

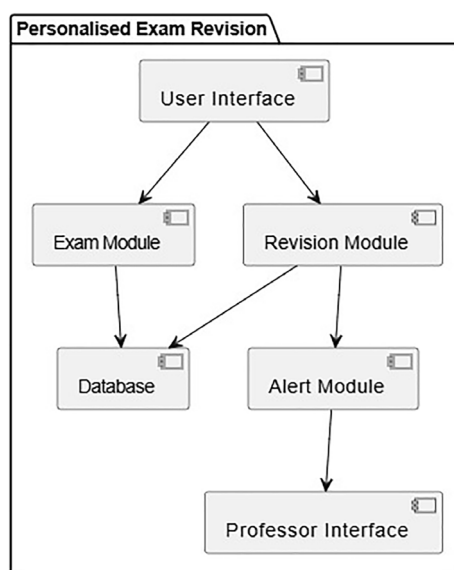


Fig. 8. Component diagram

With this environment in place, we were able to begin our exploration of MOODLE's existing adaptive editing plug-ins. Then, as part of the MVP concept, we'll start with a small module to begin and test essential functionality. This step was fundamental in identifying the strengths and weaknesses of current time-saving and user-focused solutions.

7 FUTURE WORKS AND CHALLENGES

Students' individual needs and learning styles require tools and methods adapted to the current dynamics of education. This paper examines the possibilities and difficulties of installing an adaptive revision plug-in on MOODLE. Comparative studies of plug-ins already in place have provided us with valuable information on their benefits and disadvantages, giving us a solid basis for designing our own solution. In our approach, we emphasised the importance of instructional design throughout the process, using the ADDIE method as a foundation. Our adaptive revision plug-in has been developed in a modular and extensible way, which facilitates its integration with MOODLE and allows for future adjustments. The preliminary architecture of the system was presented. In our future work, we intend to advance and finalise the remaining phases of this methodological approach by scheduling the following actions: large-scale implementation of the plug-in within the university, followed by a pilot study to test and evaluate its effectiveness with lecturer-researchers. In addition, we will incorporate the experience feedback from all users in order to complete the ADDIE loop and ensure continuous improvement of the system. Also, we intend to implement stringent security and ethical protocols, specifically the anonymisation of students' and teachers' first and last names, to safeguard the confidentiality of their data. Additionally, a pilot study will be conducted with a cohort of students to assess usability and efficacy.

As we continue to work on the development of the plug-in, the main objective remains to offer a truly personalised learning experience. A solution that not only identifies students' areas of weakness but also provides the resources and support needed to bridge those gaps. Although these results seem anticipated, we will undoubtedly validate them through forthcoming empirical studies. This study is just one step in the quest for more adaptive, responsive and objective assessment.

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