The Classification Module Intended to Be Used in The Didactic Assessment

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The paper's purpose is to describe a modular component of a complex system capable of generating didactic assessment test items with a pronounced adaptive character. The respective component has a potential for integration into various Learning Management Systems (LMS) platforms, such as Moodle, and could be exploited by a wide range of users: from teachers and students enrolled in various forms and/or levels of education to LMS platform administrators and LMS systems' developers, accessible in open-source and/or commercial formats. From a technical perspective, the component represents a classifier that turns out to be a fragment of a program product that interacts with the database, but especially with the LMS system question bank, created by the course developer, in order to satisfy the functionalities of the software product in question. The developed classification module was designed to operate based on labels created through artificial intelligence (AI) and machine learning (ML). Thanks to the aspects specified at the implementation level, AI and ML, these bring the respective classifier into the category of supervised learning program products. Aligning with national and international trends regarding the educational system's digitalization, this paper falls into fields such as applied computer science, software engineering, and artificial intelligence.
Keywords: *Modular classifier component, Labels classifier, Supervised learning, Educational program product, AI for e-learning*
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1 Introduction

Assessment has always been a basic component for the vast majority of educational sciences: general pedagogy, training theory and methodology, didactic assessment theory and methodology. A special place has been and continues to be reserved for the assessment within particular didactics, disciplines valued at all stages of schooling and professionalization [1], starting with early childhood education, primary and/or general school, up to vocational, university, and/or postgraduate studies [2], or those of lifelong learning.

Along with technological development, the digitalization of education is transformed from a simple desire into a trend that marks the development of a considerable number of processes related to the given field and innovative technological options, volens nolens, awaken in the imagination of developers' ideas of non-trivial solutions that would expand the area of their integration in order to improve, plasticize, and personalize the teaching process. The authors of this research have set themselves the goal of describing a modular software solution, of their own design, to be integrated into complex systems such as Learning Management System (LMS) platforms.

The research problem arises from the fact that: if we start from the current state of things, although among the facilities offered by LMS platforms we attest a series of tools that offer teachers the freedom to personalize the teaching process, by adding, modifying and / or using options / activities and resources according to the needs of the didactic design, as well as the specifics of the discipline, their preparation by the teaching staff in any case proves to be time-consuming, must often be reviewed, completed, and very often restarted from scratch, so as to meet the needs of training and / or individual learning path of the student who uses the respective course / courses and / or didactic content offered by the given digital format.

Despite the effort made by the teaching staff in adjusting the courses placed on the LMS, they remain quite rigid and cannot be characterized as having a high degree of adaptability in many teaching-learning situations, but especially in assessment.

The developed solution is made by own design and, being proposed by the authors for presentation within the framework of this research, was thought up and developed following the objectives listed below:

- Analysis of the research context and formulation of the categorical apparatus at the given levels: description of the research problem and objectives;
- Elaboration and description of the authors' concept of a classification module intended to be used in the didactic assessment at the level of key-users, roles of key-users, main functionalities;
- Reflections on the development potential of the current solution;
- Formulation of conclusions.

When developing the research, the authors implemented the following methods: analysis and synthesis of the research framework based on a brief literature review; creation and design of the didactic assessment classifier to be integrated into LMS platforms; development of the proposed solution, which is based on machine learning labelling; description of the development; critical analysis of the perspectives of the developed solution

2 The Analysis of Topics Related to the Current Research

2.1. Didactic Assessment in the Context of Research

By its essence, the assessment, being an "integral part of education", largely belongs to formal education (sometimes being implemented in informal educational circumstances but even more rarely in non-formal ones). Thus, education carried out "within an educational institution, broadly speaking, can be defined as a didactic process between two actors - the student and the teacher - and involves (1). the assimilation of knowledge – learning - by those defined as students and (2). the transmission of knowledge by those defined as teachers" [3].

Adhering to the opinion expressed by the authors of the study, Elena Tiron, Tudor Stanciu, according to which "didactics is defined in its multiple and interdependent meanings as the art, technology, and science of the process of education and training in an educational context, in all types of school and university institutions, at all levels of education, of teaching, learning, and assessment" [4, p. 21], our paper aims to emphasize the technological and digitalized character that the educational process, especially assessment, tends to have at present.

Starting from the inter- and trans-disciplinarity of our topic, it is worth mentioning that its coverage area is outlined from the interference of several research fields, such as education with all its arsenal of theories and ideas tangential to didactic assessment, systems engineering, software product development, these having incursions of artificial intelligence, machine learning, and, more precisely, classification.

Specificity of the research Our focus is on a broad spectrum of concepts from the various scientific fields listed above. Thus, scientific works were studied that analyze at a theoretical level notions, phenomena, and processes, operationalized by the authors in the proposed technological solution, as follows:

- The dimension of educational sciences was valued by the authors from the praxiological perspective of the customized learning experience, which operates with concepts such as student-cantered learning [1], [2], personalized learning experience [2], [3], [5], [6], adaptive assessments [7], [8], engagement and motivation [9], [10], assessment of the learning outcomes [11-14], connections of digital assessment with various tools [15] [16], including LMS platforms that can support such types of didactic interactions [17-21].
- The dimension determined by systems engineering and software product

development is researched by the authors Čech, Goubej, Sobota, and Visioli [22].

- The dimension determined by artificial intelligence and machine learning has been researched by authors such as Donos & Ciorbă [23]. We also find the author's reflections on the application of artificial intelligence in education as follows: "21st century education also tends to assert itself as a science with an innovative, sustainable spirit, oriented towards the formation of an intelligent, creative, and critical individual as well as constructive and responsible behaviors both towards their own future and for the future of the community/communities they are part of" [24].

2.2. About Machine Learning's Classification

Machine learning (ML) is a field of study in artificial intelligence whose main concern is the development and study of algorithms that allow computing systems to learn from collected and/or generated data, processed for making decisions and/or predictions, without being explicitly programmed for those operations. Machine learning algorithms include supervised, unsupervised, and reinforcement learning. Machine learning classification falls under the category of supervised learning.

Classification is one of the two main types of supervised learning techniques (regression being the other). Classification models predict a class label, such as whether a customer will return or not, whether a particular transaction is fraudulent or not, or whether a particular image is a machine or not, in our case, the label will allow us to determine the level of knowledge and/or skills to which the question in the didactic assessment test falls and/or the learner being assessed in the given test.

In general, classification is a supervised machine learning method in which the model tries to predict the correct label for the input data with which the IT solution operates. In classification, the model is fully trained using training data and then evaluated on test data before being used to make predictions on new data.

3. The Classification Module Intended to Be Used in the Didactic Assessment

3.1. The Aspects of Conceptualization of the Solution

The concept of our solution is based on the idea of personalized [3], [5-7], [12] and adaptive [8] assessment, which in the case of our research, being carried out in a Moodle test format, has the property of self-adjusting, depending on the actual number of previous student answers provided and/or collected in the previous tests placed within the course on the current LMS platform.

The test already formed by the teacher is based on the question bank on which the teacher continuously works throughout the teaching, development, and maintenance of the course in the LMS format, because it is no secret that these should be constantly updated. Speaking of LMS course maintenance, we refer not only to periodic updates but also to the completion of the content and teaching activities according to the necessary changes that are imposed by: new versions of the curriculum, approaches to the studied topics, and/or even the emergence of new subjects to study.

Thus, thanks to our solution, each test is personalized to match the level of knowledge of each student depending on his initial level of preparation, dynamics, and individual pace of learning. For example, if a student is experiencing difficulties, the test passed through the mechanism proposed by us will include easier questions, ensuring a smoother increase and dynamics of performance, and, conversely, if the student performs well, he will receive questions with a more advanced degree of difficulty and/or complexity.

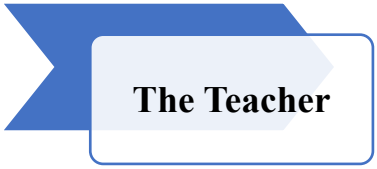
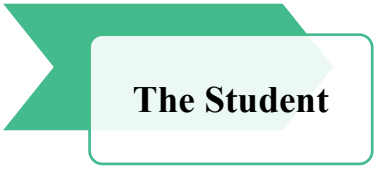
The goal is for each learner learning from a course placed on an LMS platform to perform and receive relevant personalized challenges that help them accumulate specific knowledge and skills in a constructive and efficient teaching context, excluding unrealistic expectations of both the teacher and the student.

From a technical point of view, our solution turns out to be our classification module for teaching assessments, incorporating integrative aspects of artificial intelligence at the LMS platform level, for example, Moodle.

3.2. Key Aspects of the Design and Operation of the Proposed Solution

Moodle, in particular, is open-source, and this solution could be placed on GitHub or other software development solution sharing platforms, or it could be commercialized.

Table 1. The key users and their roles in the view of authors' classifier

		
Teachers: **Create the tests and set the difficulty levels.**	**Students:** **Take the tests and receive the personalized assessments.**	**AI Model:** **Analyses the results and adjust the difficulty levels.**
– **The role:** Teachers act as the primary content creators in the system.	– **The role:** Students are the end-users of the adaptive assessment system.	– **The role:** The AI model operates as the brain behind the adaptive system, managing and fine-tuning the assessment process.
– **The responsibilities:** ○ **Creating Initial Tests:** Teachers design the test structure and select relevant questions from the system's question pool. ○ **Setting Difficulty Levels:** They assign appropriate difficulty levels to questions based on course content (e.g., easy, intermediate, advanced). ○ **Providing Subject Matter Expertise:** Teachers ensure that the assessments are aligned with learning outcomes.	– **The experience:** ○ **Taking Tests:** Students access tests through the LMS (e.g., Moodle) on their devices, engaging with questions tailored to their skill levels. ○ **Receiving Personalized Feedback:** Based on performance, the system provides specific feedback to guide improvement. ○ **Learning Continuity:** If students struggle, easier questions are presented to rebuild foundational knowledge. If they excel, more challenging questions are given to promote growth.	– **The responsibilities:** ○ **Analyzing Test Results:** The AI collects data from each student's performance (e.g., right and wrong answers, completion time). ○ **Adjusting Question Difficulty:** It recalibrates question difficulty for each student, ensuring that future tests align with their current ability. ○ **Providing Feedback to Teachers:** The AI generates reports that help teachers understand class performance trends and individual progress. ○ **Continuous Learning:** The model evolves as more data is collected, becoming better at predicting student needs and adapting assessments over time.
– **The benefits:** Teachers can offer personalized challenges to students by setting initial difficulty levels, which the system then fine-tunes based on real-time performance.	– **The benefits:** Students receive assessments suited to their learning pace, keeping them motivated and engaged, while avoiding frustration or boredom.	– **The benefits:** The AI ensures that assessments are continually personalized for each student, maximizing the effectiveness of learning without manual intervention.

The design of our solution is modular and can be integrated into any LMS platform. As a result of this integration, the LMS system adjusts the difficulty of the questions in real-time, depending on scenarios such as:
(A.) If the student involved in the Moodle test makes a mistake on a question, the next question offered by the system will be an easier one to give him a chance to better understand the concepts in a gradual format; or
(B.) If the student answers the questions with a higher degree of difficulty correctly, the test will continue to run, generating more complex questions and thus raising the level of challenge for the learner. In the case of a student who performs well and/or very well, this system is both one with a motivational impact and one that excludes the appearance of boredom and/or disinterest.
In the context of our solution, assessment becomes a continuous process of adjusting the complexity of the contents included in the assessment, which in our opinion will better fit the formation and progressive development of each student's skills. Another essential aspect of our system is its ability to provide automated feedback. The artificial intelligence (AI) model developed and integrated by the authors analyses student responses and generates reports for both students and teachers. Teachers receive information about each student's progress, and students receive recommendations for improvement. This feedback loop ensures an efficient educational process focused on the continuous development of the learner's skills.
The questions in the tests that our solution operates with are taken from the question bank created by the teacher who manages the course content placed on the LMS platform and are organized based on two main tags, as follows:

- **Difficulty** determines the degree of complexity of the question after which the test will be developed by the implemented AI model but also establishes the student's level of competence, here being tags such as Easy, Intermediate, and Difficult.
- **The topic** is related to the area of study, object, theme, etc., for example: programming, mathematics, etc. These tags help the AI model select the relevant questions for each student, ensuring that the assessment is adapted according to the knowledge and needs of each.

As users, key users, of our solution, there are three basic categories (see Table 1).
Our Classifier works being based on the Supervised Learning (SL) Model. Speaking about the SL this is a type of machine learning where the system learns from labelled data. In the context of your adaptive assessment system:
1. **The Training Data.** Historical student responses and outcomes (e.g., which questions were answered correctly or incorrectly).
2. **The Labels.** Tags assigned to questions that define their difficulty (e.g., Easy, Intermediate, Hard) and context (e.g., topic categories such as Math or Programming).
3. **The Goal.** To predict the next suitable question for a student based on their performance and assign appropriate difficulty levels.
Developed classifier uses AI to analyse test results and continuously improve the learning process, see the Table 2.

Table 2. The Python code regarding the interaction of learner user with the LMS test question

```
# Each row is a student's interaction with a question
data = {
        # Student's last score
        previous_score': [0.5, 0.8, 0.3, 0.7, 0.6, 0.2],
        # 0 = Easy, 1 = Intermediate, 2 = Hard
        'question_difficulty': [1, 2, 0, 1, 2, 0],
        # 1 = Python, 2 = Algorithms
        'topic': [1, 2, 1, 1, 2, 1],
        # Target (predicted difficulty)
        'next_question_difficulty': [1, 2, 0, 1, 2, 0]
}
```

Technically, the authors' classifier solution is working using Python for the AI model and FastAPI for integration with Moodle. In this way, we offer and ensure a fast and efficient system for adaptive assessments.

While Python is known for its simplicity and rich ecosystem for machine learning (e.g., scikit-learn, TensorFlow, PyTorch) and is considered a suitable toolset for deploying models because of its scalability and flexibility, FastAPI is a modern Web framework for building APIs, known for being lightweight and high-performance. FastAPI simplifies the process of exposing your AI model to external applications like Moodle via HTTP requests.

Also, FastAPI supports asynchronous processing, making it efficient when handling multiple requests, such as student test submissions.

The developed system continuously adapts, making assessments more relevant and tailored to the learner's current knowledge. In a brief overview of the architecture, it can be specified the following (see Figure 1):

- A teacher or student interacts with the Moodle platform.
- Moodle sends a request (e.g., a student's answers or request for the next question) to the AI model via the FastAPI interface.
- The AI Model processes the data, predicts the appropriate difficulty level or next question, and sends the result back through FastAPI.
- Moodle receives the response and updates the student's assessment dynamically

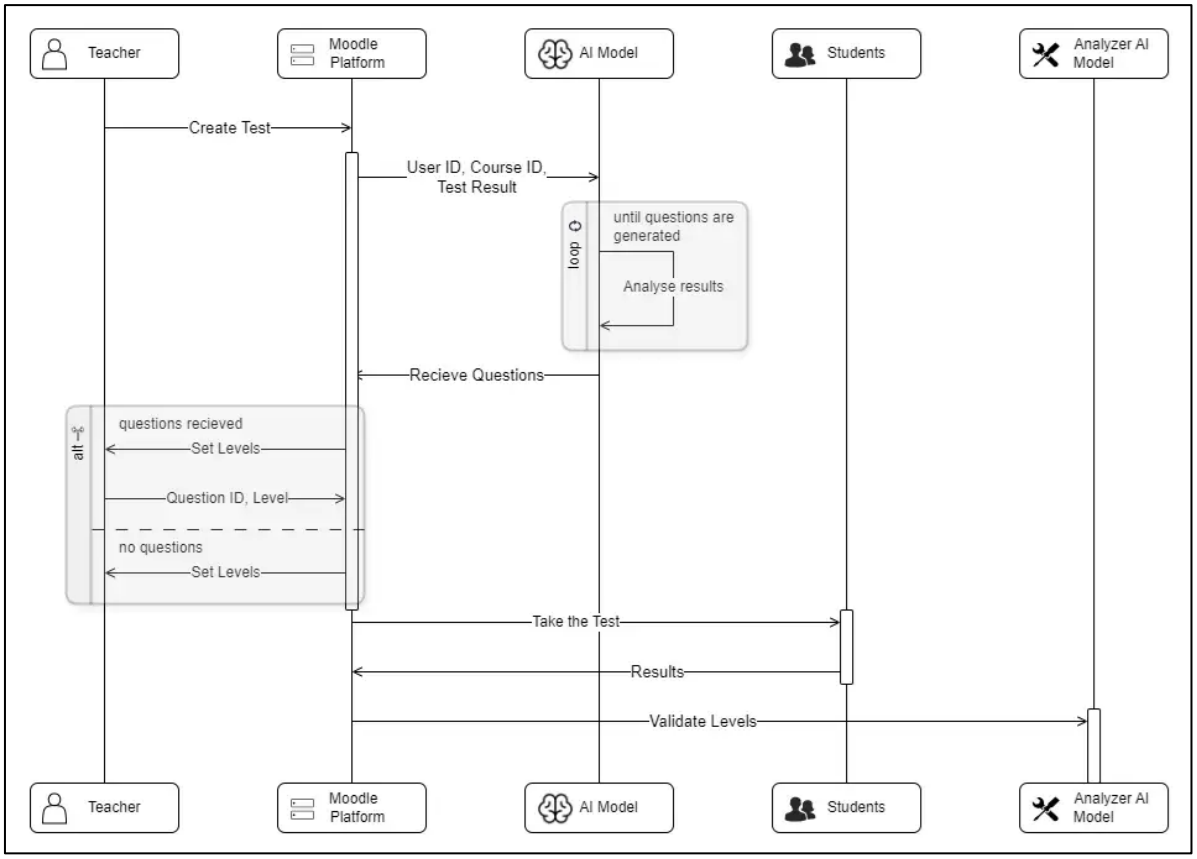


Fig. 1. The full diagram of the developed classification solution: the functionalities, the roles of key users, and their interactions.

4. Future Research and Development

Being given the specifics of the proposed solution, implemented and described in this paper, we consider the Classification Module Intended to Be Used in the Didactic Assessment viable, and among its possible development perspectives, we see the following:

- Automatic generation of tests based on the existing material on the course page on the given LSM platform, but also updating the automatically generated versions according to new materials uploaded by the teacher administering the course;
- Unified and systemic testing of courses with similar content existing on LMS platforms at various universities;
- Generation of personalized courses tailored to the learning dynamics of each student;
- Generation of individual courses for students with special educational needs.

We consider this position feasible and of major importance, especially because the context of local educational policies allows and technologically supports such innovations [25].

5. Conclusions

As authors, we have identified the possibility of developing a mechanism for verifying and controlling learning outcomes, as well as for stimulating and motivating learning by directing the process of assimilating didactic content, which will be directly reflected in the didactic assessment process and will subsequently have a positive impact on the level of learning outcomes demonstrated by the learners-beneficiaries who will use the current solution. Increasing the quality of learning outcomes is achieved by technologically improving the existing assessment tool in modern LMS platforms, a perfect example of which is the Moodle system.

The classification solution developed and described in this research was designed and is to be partially implemented in such a system. Its implementation will be carried out in a digital modular format for the purpose of further testing.

The current development is part of overall applied research that will materialize in a final project at the "Data Science" master's program at the Technical University of Moldova. A few aspects related with given research have been presented at International Conference on Electronics, Communications and Computing, ECCO – 2024.

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