BEST PRACTICES FOR PARAMETRIC TESTING IN MATHEMATICS

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Abstract. *Digital educational resources enhance learning by promoting personalized experiences.* This study examines the use of **IDER in Moodle** to generate adaptive mathematical exercises. Conducted with 60 middle school students, the study followed an **experimental design (pre-test, intervention, post-test).** Results show that **IDER-based assessments significantly improve mathematical understanding and problem-solving skills**, contributing to digital assessment methodologies and adaptive learning. (Andrei&Stoica 32; Cîrlea 45).

Keywords*:* Moodle, Individual Digital Educational Resources (IDER), Mathematics, Adaptive learning

JEL: I21, C63, C88.

INTRODUCTION

Investigated problem: On one hand, **static online tests compromise assessment quality** because students can quickly access pre-collected answers from databases. The **widespread availability of ICT tools** (*computers, tablets, mobile phones, smartwatches*) further facilitates academic dishonesty, even when exams contain **thousands of randomized items.**

On the other hand, **manually creating and grading** personalized tasks for each student **is not feasible** for teachers, making traditional assessment methods **both ineffective and unsustainable** (Bragaru & Arnăut, 78).

Hypothesis supported by authors and relevant results obtained: Instead of static test items in mathematics, individualized items with different values at each test launch should be used. These items ***can be generated in any required number of copies*** according to parameterized models/formulas. The parameters/variable values will be specified by teachers according to needs, including different difficulty levels. Individualized items offer multiple advantages, including:

- **Drastically reducing (almost to zero) the possibility of fraud by copying pre-collected/stored answers**, as these task values are unknown even to the teacher. Answers can only be determined through problem-solving.
- **Encouraging learning rather than copying** previous solutions.
- **Saving teachers' time** for routine tasks such as manually preparing and grading tests.
- Ensuring ***item universality***: they can be used repeatedly by any teacher in any institution and have an unlimited lifespan (Mihailescu 123).

Relevance and **importance** are supported by:
a) **The shortage of qualified mathematics teachers**, which ranges **between 10% - 20%** in some regions and can reach 30% in rural and underdeveloped areas ("Ministry of Education Report" 2023).
b) The **limited time** teachers have to effectively assess a large number of papers, preventing the timely provision of personalized feedback (Manea 56).

OBJECTIVES AND METHODOLOGY

The **purpose** of the work is to increase the efficiency and quality of assessments on account of:
a1) Generating any number of individual items required;
a2) Saving the time required for the composition and correction of items at the individual level of the teacher;
a3) At scale per entity and
a4) At scale/ministry level across all entities;
b1) Significant reduction of copying possibilities;
b2) Increasing students' mathematical acquisition based on repeated online (self) assessment, unlimited practice, keeping motivation;
b3) Reduction of mechanical memorization and emphasis on conceptual understanding, etc.

Specific objectives include exploring Moodle's opportunities for developing individual digital educational resources/IDER by generating parameterized tasks and testing tailored to individual student/student progress.

1. Parametric evaluation and educational games in Moodle

Moodle offers a wide range of items suitable for testing mathematical knowledge such as M**ultiple choice questions, Solving calculation problems**, **Thematic games**.
Moodle allows the implementation of a structured parametric assessment framework, including:

1. **Defining variables**: Teachers define key mathematical variables and formulas.
2. **Automatic question generation**: Moodle assigns random numerical values to variables within predefined limits.
3. **Individualized assessments**: Each student receives a unique set of exercises, thus reducing the possibility of rote memorization and cheating.
4. **Use of interactive educational games**, such as quizzes, mathematical puzzles, drag-and-drop exercises.

Learning through play is more effective. Using interactive educational games such as *drag-and-drop exercises, math puzzles, matching games, millionaire, crosswords*, etc. contribute to the development of critical thinking, increase engagement, improve school results and ultimately lead to the **consolidation of mathematical knowledge in an interactive and engaging way**.

These methods allow personalization of the learning process and provide ***instant feedback***, adapting the difficulty level of the tests according to the individual progress of the students.

2. Practical example in 8th grade geometry:

The Hot Potatoes game allows to create interactive puzzle activities that help students apply geometric formulas to solve area and volume problems. These activities can include multiple levels of difficulty, and students must solve problems step by step to "discover" the correct solution.

📌 *General exercise formulation:* **"Calculate the total surface area of a rectangular parallelepiped with dimensions l = {x}, L = {y}, h = {z}."**

📌 *Defining variables and setting difficulty levels:*

- **Easy level:** Whole numbers between **5 and 10.**
- **Medium level:** Rational numbers with **one decimal place (0.5),** between **5 and 10.**
- **Difficult level:** Any **rational number with two decimal places** between **5 and 10.**

🔹 **Parameters are randomly generated for each student.**

📌 *Calculation formula in Moodle:* **A = 2 * L * l + 2 * L * h + 2 * l * h**

Question received by the student: "What is the total area of a rectangular parallelepiped with width 5 cm, length 8 cm and height 10 cm?"

✅ If the student answers correctly:

• **Feedback:** *"Congratulations! You answered correctly. Now try a more challenging exercise."*
• **Moodle automatically generates** an exercise with a higher difficulty level.

❌ If the student answers incorrectly:

• **Feedback:** *"Check the formula for calculating the total surface area. Did you forget to apply basic arithmetic operations correctly?"*
• **Moodle provides a link** to the theoretical lesson on the parallelepiped's surface area formula.
• **Moodle generates a new, similar exercise** but with a lower difficulty level, e.g., instead of complex decimal numbers, the student receives only whole numbers for an easier calculation.

This online item plays a crucial role in the lesson *'The Rectangular Parallelepiped: Surface areas and volume'* by ***facilitating the rapid and accurate learning of formulas*** for calculating surface areas and volume, ***aligning with the lesson's goal of developing skills and competencies through practical application.***

RESULTS AND DISCUSSION

The study was conducted within the doctoral project "Intelligent Support System for Accelerating Mathematical Acquisitions in Middle School Students" at the Doctoral School of Natural Sciences, Moldova State University. The ***practical component*** was implemented on the ***Moodle*** educational platform, using ***original parametric item models*** suitable for studying mathematics. Observations were conducted at School No. 10 in Bacău, Romania, with two parallel eighth-grade classes: one following **traditional teaching-evaluation methods** (*control group*) and the other using the **Moodle-based adaptive testing system** (*experimental group*).

The study was structured as follows:

- **Pre-test:** Establishing students' initial mathematical competency level.
- **Intervention:** Implementing IDER-based exercises in Moodle, including interactive activities such as quizzes, puzzles, and educational games.
- **Post-test:** Evaluating progress using statistical analyses.

The effectiveness of IDER-based teaching-assessment in Moodle was evaluated based on student engagement, accuracy in problem-solving, and overall performance improvement (Gagne 89).

- **25% improvement in problem-solving accuracy.**
- **Greater engagement** through interactive exercises.
- **Better concept retention** for long-term application.

These findings confirm that **IDER-based parametric testing and Moodle-integrated games significantly enhance mathematics learning.** However, **human guidance remains essential,** and digital tools should **complement, not replace,** interactive teaching strategies.

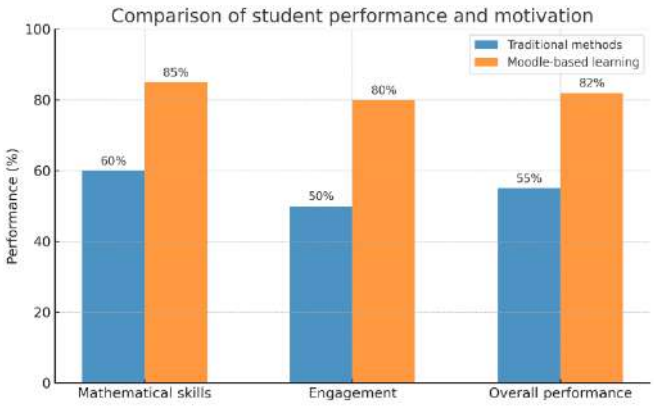


Figure 1. Comparison of the performance and motivation between the control - experimental groups

CONCLUSIONS

• **Item models parameterized** on the respective themes are **universally applicable** for the study of mathematics in any types of schools throughout the country, by all teachers.

• By dynamically generating individualized exercises and using interactive activities, IDER **minimizes the desire for mechanical memorization**, **promotes active problem solving and ensures academic integrity, making assessment more objective and impartial**.

• The comprehensive use of IDER essentially **diminishes the gap between the planned-taught-assessed curriculum**, including by different teachers.

• IDER relieves teachers of most of the routine work of composing-correcting and manual grading of items, estimated as **up to 30% of their weekly time at the expense of time they can spend on lesson planning and developing innovative teaching strategies** and more(Vasile 90).

While **e-learning tools provide major advantages, human guidance remains essential.** Digital resources should **enhance, not replace,** interactive teaching. A **balanced integration of technology** ensures deeper learning and better academic results.

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